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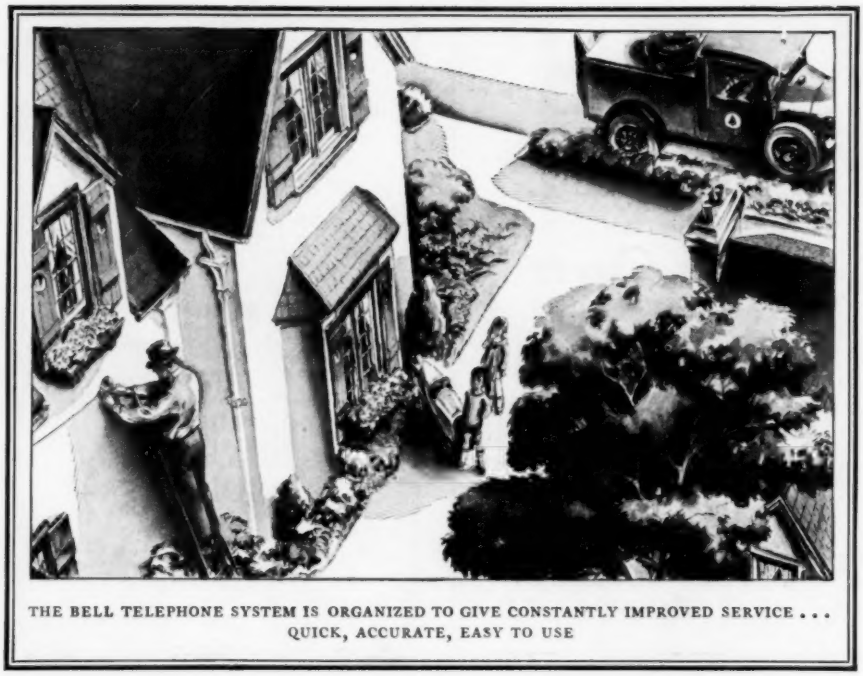

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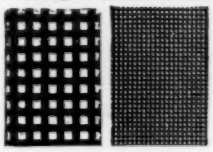

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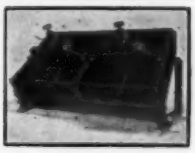

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A PROGRESS REPORT ON THE DEVELOPMENT OF AN ABRASION TEST FOR REFRACTORIES AT HIGH TEMPERATURES[1]

By Joseph B. Shaw,[2] George J. Bair,[3] and Myril C. Shaw[4]

ABSTRACT

A report of progress in the development of a method of testing refractories for their resistance to abrasion at high temperatures. The method developed consists of a steel chisel point moving back and forth over faces of the brick clamped together. Eleven brick are tested at one time. The chisel is actuated by means of a jack hammer and is water-cooled. The blow delivered varies from 6.5 inch-pounds at the beginning of the test to 13 inch-pounds under the most severe conditions. The chisel has a rounded point 1/8-inch radius and 1 inch wide. Data show that the principle is correct and capable of differentiating between brick of varying resistances to abrasion at temperatures as high as 1350°C.

Introduction

The Committee on Refractories (C8), A.S.T.M., has worked for several years on the problem of the resistance of refractories materials to abrasion. Not much of this work has been published.

The correspondence files of the members of that committee have therefore been the principal guidance in this investigation.

Summary of Correspondence and Discussion

The consensus of opinion is that fire brick are subjected to severe abrasion in many places where they are used, that the degree of abrasion is sometimes very severe and an important factor in determining the life of the refractory, and that the character of the abrading material combined with the conditions of temperatures and furnace gases introduces variables which make it desirable to know how different kinds of refractories withstand abrasion under these various conditions.

Stated more simply, a test for abrasion at high temperatures is very desirable.

The development of this test involves difficulties. There is a considerable body of opinion that no single test for abrasion is likely to prove satisfactory because the abrasion to which refractory materials are subjected is of two distinctly different types: (1) fine dust particles hurled against the refractory in a stream of hot gas moving with considerable velocity and (2) the downward movement of the charge of sharp, angular fragments of limestone, coke, or iron ore under high pressure and sometimes falling against the refractory, the sharp edges striking a severe blow. This latter type of abrasion produces the destruction of the refractory

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont. February, 1930 (Refractories Division).

[2] Head, Department of Ceramics, Pennsylvania State College.

[3] Instructor in Ceramics, Pennsylvania State College.

[4] Graduate Student, Ceramics, Pennsylvania State College.

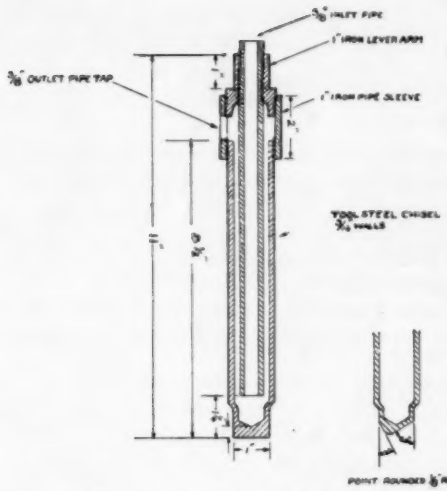

FIG. 1.—Details of water-cooled chisel point. Shaded portions indicate depth of groove cut with 163 blows per brick.

by a gouging action or by rupturing of the bond between particles on the surface, and differs materially from the destruction resulting from dust in the gas stream.

A satisfactory abrasion test must measure the resistance to destruction under both types of service.

There has been a great deal of theorizing on the basis of which cold tests have been adopted and measurements made of resistance to abrasion when cold, and it has been assumed that the results obtained in such cold tests would apply to the refractory if it were tested at high temperatures. Much work has been done in determining the resistance to abrasion on cold fire brick. Practically no data are available on similar tests at high temperatures.

Tests Tried

The tests which have been developed and proposed for use are here outlined. The discussion relative to each of these tests is the consensus of opinion of a great many interested persons who entered into the correspondence in response to requests for such discussion by L. C. Hewitt, Chairman Sub-Committee on Abrasion.

(1) Emery Wheel Test Apparatus described by Harvey and McGee[5] consisted of a grinding wheel pressed against the surface to be tested, the speed of rotation, time, and pressure being constant. The amount of material ground away was the measure of resistance to abrasion.

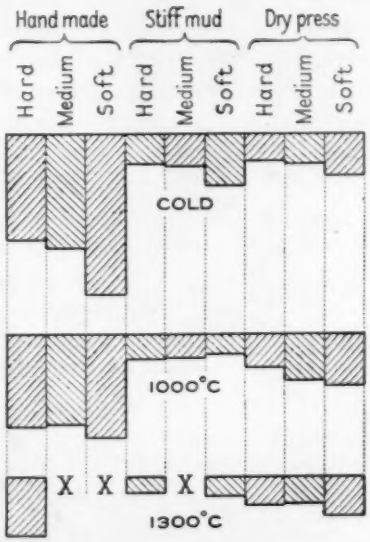

FIG. 2.—Comparing effect of process of manufacture on resistance to abrasion. Shaded portions indicate depth of groove cut with 163 blows per brick.

[5] *Jour. Amer. Ceram. Soc.*, **7**, 895 (1924).

This test is applicable to refractories and other materials at atmospheric temperatures but cannot be applied at elevated temperatures.

Nesbitt and Bell[6] modified this test by first heating the test brick to 1350°C, then withdrawing it from the furnace and subjecting it to the abrasive action of the grinding wheel. In this procedure the loss from spalling was severe due to sudden change of temperature, and the loss actually produced by the wheel is considered largely a spalling action rather than abrasion comparable with the same loss made when the brick and grinding wheel are at the same temperature. The emery wheel also tended to polish the surface of the brick rather than to grind it away.

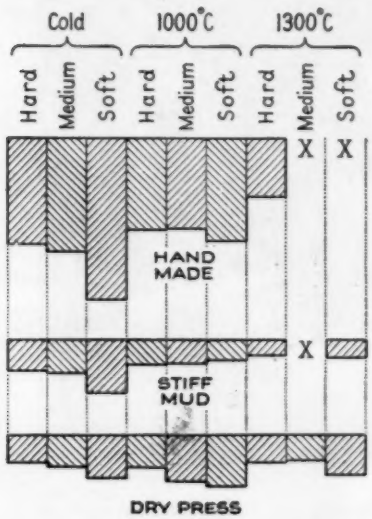

FIG. 3.—Comparing effect of temperature of firing on resistance to abrasion. Shaded portions indicate depth of groove cut with 163 blows per brick.

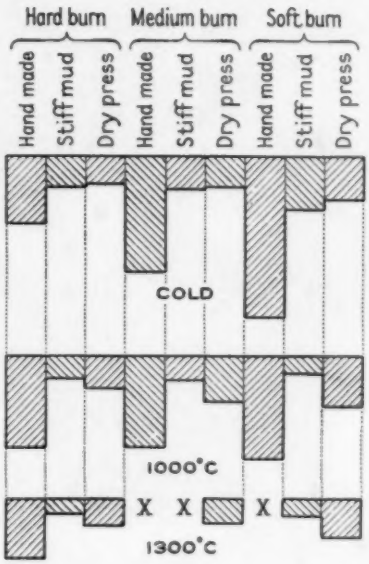

FIG. 4.—Comparing results of abrasion at different temperatures. Shaded portions indicate depth of groove cut with 163 blows per brick.

(2) Rubbing Test Hancock and King[7] clamped a weighed test brick to a reciprocating arm and slid it back and forth over another brick of the same material or of some selected standard.

This test failed to simulate service conditions, there was a tendency for the refractory to be polished in the rubbing action instead of abraded away, and the fine powder produced in early portions of the test served as a protecting coating on the surface of the brick under test.

---

[6] *Jour. Amer. Electrochem. Soc.*, 1920.

[7] *Trans. Ceram. Soc.* [Eng.], **22**, 316 (1922–23).

(3) Rattler Test Cole[8] modified the paving brick rattler test to make it applicable to silica brick. The percentage loss by weight taken after 600 revolutions of the rattler was considered a measure of resistance to abrasion.

This test is applicable only to cold brick and is subject to all of the criticism which the rattler test for paving brick has received since its adoption. The major portion of the abrasion in this test takes place on the sharp edges and corners of the brick, which portions are protected

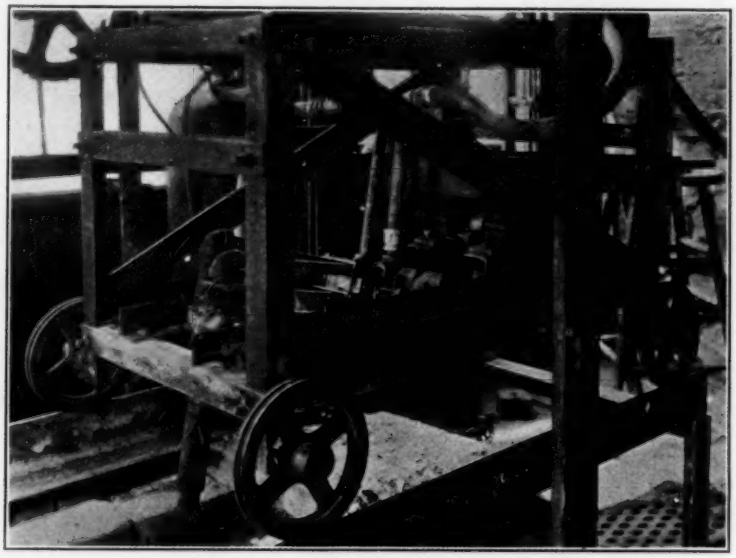

FIG. 5.—Chisel with jack hammer operating mechanism and carriage.

when the brick is in service. The test has been applied to silica brick only, no effort having been made to apply it to fireclay brick.

(4) Scratching Test A crystalline stylus was mounted on a carriage. This stylus bearing down at a known pressure was made to move forward and backward over the test brick. The depth of cut made in a given number of strokes was compared with a similar cut on a standard material.

This test is admittedly a measure of the resistance to the gouging out of grains, no statement being made as to whether or not it would be applicable under hot conditions.

(5) Rotating Disk Test A horizontal, rotating disk was dusted with a known weight of emery powder of standard

[8] *Proc. A.S.T.M.*, **29**, Part 1, p. 288.

grade. Weighed test pieces were brought in contact with the disk under definite pressure, held there for a given number of revolutions, and again weighed.

The rotating disk test is considered applicable only to cold brick and therefore objectionable because it does not simulate service conditions.

(6) Sandblast Test Mr. Brady of the U. G. I. developed an apparatus for determining the resistance of fire brick to sandblast. Apparatus was constructed and tests made on cold brick. The result of the test indicated that this method offers promise of more nearly measuring the resistance of refractories to abrasion than any previously proposed test. It was accordingly modified for use on hot brick. After much experimenting it was found necessary to heat not only the brick but the sand and air as well. No great amount of data were obtained upon brick at high temperatures. It was admitted, however, that there were many variables in the test which were difficult to control and, while this method of testing seems to offer considerable promise, there is a possibility that it will be found impractical to standardize such a method because of the difficulty of controlling all of the variable conditions.

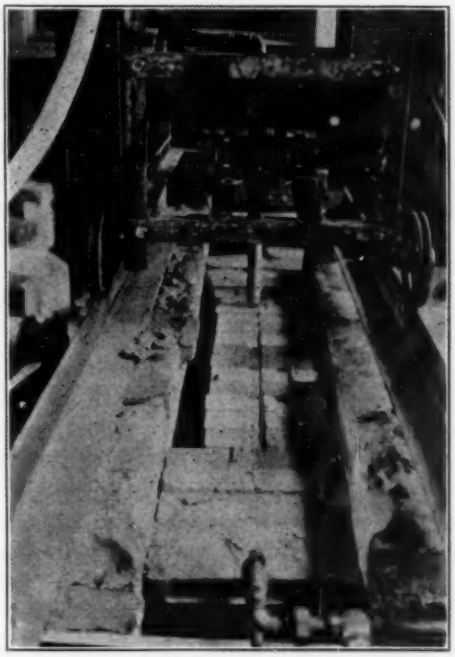

FIG. 6.—Showing brick in place after testing. Groove cut by chisel.

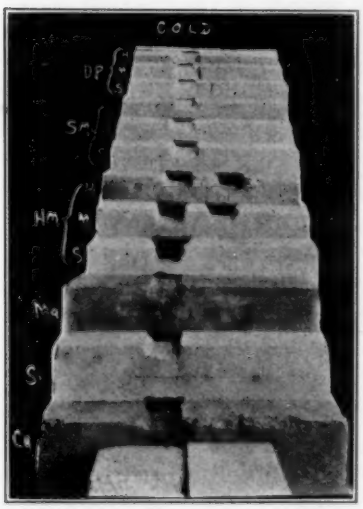

FIG. 7.—Showing depth of groove cut by chisel when brick are cold.

A Simulative Service Test

No test for this purpose will be satisfactory unless it is substantially a simulative service test. This means that

the brick must be tested at the temperatures at which they are to be used and the character of the abrasion and of the abrading material must be similar to that actually found in service.

There is no doubt that the abrasive destruction of refractories in service results from two distinctly different types of abrasion. The cutting action of flue gases carrying clouds of fine sharp dust and granular material is similar to the cutting away in a sandblast test. On the other hand, a different type of abrasion results in the destruction of refractories in fire boxes of furnaces and boilers where the fireman stokes his fire with a cold, sharp stoking iron, and in the walls of blast furnaces and lime kilns, where the abrading material consists of large angular fragments more or less sharp edged which strike the refractory at considerable velocity. This latter type of abrasion is undoubtedly much more prevalent and far more destructive.

It was decided, therefore, to develop a method of testing the resistance of refractories at high temperatures to abrasion of the latter and more prevalent type.

To develop a test which may be standardized it is essential that the character of the abrading materials and the conditions of their use be capable of accurate control, and that it be simple and easily reproducible. The device should be simple in operation, capable of accurate control under high temperature conditions, and indestructible under the conditions met with in the test.

An air hammer actuating a chisel point whereby a series of blows in rapid succession might be delivered to the surface of the material under test offered a method worthy of trial. It was believed that the angle at which the chisel struck the refractory could be so regulated as to introduce the gouging effect of the stylus; the shape of the point, and the force of the blow could be varied from a light tap to a heavy, sledge hammer blow.

The Chisel The first problem was to obtain a suitable material from which to make a chisel which would not deteriorate when operating on refractories at temperatures from atmospheric to 1300°C. Two possibilities were open: first, the chisel might be made from some refractory material which would be tough and strong so as to retain a point throughout this range of temperature and under the severe punishment to which it would be subjected. Second, a steel point might be constructed so as to be capable of air or water cooling. It was thought that the operation of cooling a chisel point might make it difficult to maintain the refractory at the desired high temperature.

With a view to securing a refractory material, many materials were suggested, such as crystallized fused alumina, silicon carbide, Stellite, tungsten carbide and similar alloys, mullite, etc. This part of the in-

vestigation, however, has been altogether discouraging, no satisfactory material having thus far been developed.

Some very hard and tough chisel points were obtained but they were in all cases too brittle to retain a point when working under the conditions of this test.

A steel chisel point, water-cooled at 1300°C did not cool the brick and has been found to remain practically constant throughout a long series of tests at varying temperatures up to 1350°C, and operating on all types of refractories.

The Furnace Several designs of furnaces were made and abandoned. Among them were round furnaces to be rotated with the chisel point stationary; another one was a furnace to be operated in a reciprocating motion with the brick standing on edge, the furnace to be heated from both ends. The final mechanism adopted has the furnace stationary with an oil burner at each end and of such size that eleven brick can be tested at one time.

The operating mechanism consists of a car mounted on a track immediately on top of the furnace and actuated by a reciprocating mechanism. The car carries the chisel point and moves backward and forward at the rate of 5 feet per minute.

Air Hammer The third problem was to devise a method of delivering a blow of desired force and at the desired angle to the brick under test. A Thor NN scaling hammer weighing 7 pounds, $10^1/_2$ inches overall length, and delivering 2400 blows per minute was purchased from the Independent Pneumatic Tool Company, of Pittsburgh, Pa. The chisel was attached to this hammer and the hammer set on the car at an angle of about 15° with the vertical and in such a manner as to provide free sliding motion vertically. The principle of this hammer, however, was such that there was a constant dragging action, the chisel point riding on the surface of the brick continually and blows being delivered by the plunger in the hammer. In operation this hammer proved to be unsatisfactory because of this dragging action. The chisel point moved fairly satisfactorily over the surface of the individual brick but when it came to a joint between two bricks there was a tendency for the point to dig itself in and this condition proved so serious that it was necessary to abandon the air hammer.

A jack hammer was constructed which was operated by means of a cam attached to a 900 r.p.m. motor. By means of a two-to-one gear ratio the number of blows delivered by the hammer was reduced to 450 per minute. The brick are set in powdered clay with no mortar joints between them and clamped together by steel clamps at each end of the furnace. They are set at such height with relation to the chisel point at the beginning of the test that the point has a fall of exactly 1 inch. The cam is so con-

structed that a maximum depth of 1 inch can be cut in the brick. Therefore at the end of the test, provided the brick has shown severe abrasion, the hammer may be striking with a blow resulting from a 2-inch fall of the chisel point. The actual weight of the chisel point and its attachment as operating is 6.5 pounds. This means that at the beginning of the test a blow of 6.5 inch-pounds is delivered to the surface of the brick, and under most severe conditions at the end of the test a blow of 13 inch-pounds was delivered. This means that as the test progresses, a brick, which is showing severe abrasion, will receive an increasingly greater abrasive action. It would be possible by a balancing spring to correct this variable, but it is not believed desirable to eliminate it.

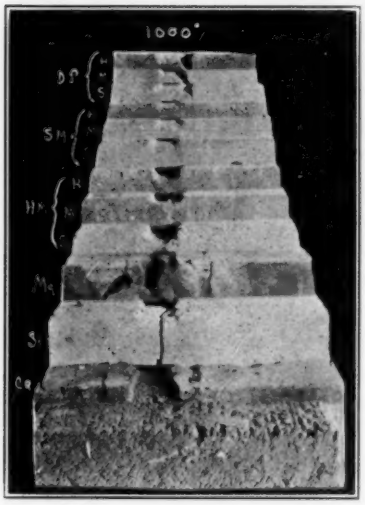

FIG. 8.—Showing depth of groove cut by chisel when brick are at 1000°C.

This jackhammer arrangement was first tried on cold brick, the results being highly encouraging. A test at 1000°C with the chisel point air-cooled gave similar encouraging results. Upon trying the same arrangement at 1300°C it was found impossible to force sufficient air through the chisel to keep it cool; as a consequence of which one of the pipe fittings melted and the test failed.

A new chisel point made by drilling a solid piece of tool steel and the one ultimately used was tried with air-cooling but the point of the chisel flattened immediately and failed to produce any abrasion on the brick. This developed the necessity for water-cooling.

The final apparatus, as shown in the photographs with a water-cooled chisel point, has proved highly satisfactory as far as results obtainable are concerned.

The set-up of the apparatus is highly objectionable because of the severe heat which arises from the furnace, which must be kept under fire throughout the test. This necessitates keeping a blast of air on the apparatus and even then it makes a very undesirable job. These conditions can be readily corrected by some modifications in the construction of the furnace. It is believed that the furnace itself should move, leaving the chisel point stationary as to the horizontal direction, and a downdraft arrangement should be constructed making it possible to carry away the heat during the test.

There is a possibility also that the jackhammer arrangement here shown can be replaced with a sand-ramming hammer which delivers a positive up and down stroke. In case the jackhammer arrangement is found most desirable it can be operated from the same power as that which operates the car or furnace, whichever is moved in a reciprocating motion.

Results

The data given in the following tables and curves show the results obtained by testing a number of brick, all of which were obtained from the same company and were selected with a view of determining whether the principle incorporated in the apparatus here described would distinguish between brick of high and low resistance to abrasion.

These data represent the results obtained on a very limited number of brick and, while it might be interpreted to indicate a superiority of one process of manufacture over another or of hard firing over light firing, such interpretation is not justified at this time. The number of tests made is altogether too few to draw any conclusions on the basis of these results with reference to the brick themselves.

The very evident variation shown in the tables and curves indicates strongly that the method here outlined for testing such brick is capable of sufficient refinement to enable one to definitely distinguish between brick of high and low resistance.

We wish to emphasize the fact that this whole investigation is a test of this method for determining resistance to abrasion, and not a test of the brick on which data have been obtained and are here reported.

DEPTH OF GROOVE IN MILLIMETERS CUT ACROSS FACE OF BRICK WITH 8 TRIPS OF CHISEL

(Each brick subjected to 163 blows; figures represent average of 3 readings taken in middle 3 centimeters of the face)

	Cold	1000°C	1350°C
Hand made (soft mud):			
Hard firing	13.2	11.4	7.3
Medium firing	14.3	11.3	
Light firing	20.0	12.8	
Stiff mud (repress):			
Hard firing	3.8	2.9	1.7
Medium firing	4.0	2.8	
Light firing	6.5	2.3	2.0
Dry press:			
Hard firing	3.3	4.0	3.2
Medium firing	3.8	5.7	3.0
Light firing	5.2	6.1	4.8
Silica	10.3	3.8	8.8
Magnesite	3.5	2.8	7.5
Chrome	7.2	7.8	13.5

SAME DATA REARRANGED

	Cold	1000°C	1350°C
Hard firing:			
Hand made	13.2	11.4	7.3
Stiff mud	3.8	2.9	1.7
Dry press	3.3	4.0	3.2
Medium firing:			
Hand made	14.3	11.3	
Stiff mud	4.0	2.8	
Dry press	3.8	5.7	3.0
Light firing:			
Hand made	20.0	12.8	
Stiff mud	6.5	2.3	2.0
Dry press	5.2	6.1	4.8

Conclusion

The results obtained seem to indicate rather definitely that there is a distinct difference in the ability of fire brick to resist abrasion at high and low temperatures.

They seem to indicate further that there may be a marked difference in the ability of brick fired hard and those fired light to resist abrasion at various temperatures.

They indicate that there may be a difference in the ability of brick manufactured by different processes to resist abrasion at various temperatures.

The evidence obtained thus far seems to justify the opinion of those who have worked on this problem that a test for the resistance of fire brick to abrasion at high temperatures is desirable and if it is to be useful it must be capable of simulating service conditions with a reasonable degree of accuracy.

The ultimate result of the investigation thus far encourages one to believe that the method here partially developed is worthy of further refinement, and it seems probable that it can be sufficiently simplified to make the apparatus economical to construct and use and that it will produce the desired results.

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THERMAL EXPANSION OF SILICA BRICK AND MORTARS[1]

By Sandford S. Cole[2]

ABSTRACT

Thermal expansion from 20 to 950 °C and physical data of silica brick from various producing districts in the United States and Europe are presented. The variations in thermal expansion of brick from various parts of kilns are given for plants in the United States.

The magnitude of variation of the thermal expansion of silica brick is quite small, the expansion ranging between 1.15% and 1.30% at the highest point of expansion. The expansion of the silica mortars varied between 1.30 to 1.52% depending upon variations in clay, quartzite, and bats.

The variations in thermal expansion of silica mortars from various producing plants are also shown. Data on the effect of size of grain, clay content, and P.C.E. on the thermal expansion of mortars are given. An extensive bibliography on thermal expansion of silica brick appears with the paper.

Introduction

The thermal expansion of the various components of silica brick has been studied by many investigators. Data on the thermal expansion of silica brick have been published to a rather limited degree, but little or no information has been available concerning the expansion of mortars used for laying silica refractories. Data on the thermal dilatation of silica mortars and the variations that might occur due to variable clay content, amount of silica bats and quartzite present, and grain size are of interest and value to any user. Information is also quite limited as to variations in the thermal expansion characteristics of brick fired in the same kiln, brick made of different quartzites, and brick made of similar quartzites in two plants.

The data presented by Travers and de Goloubinoff, Van Nieuwenburg and Zijlstra, and Souder and Hidnert[3] are the most recent and appear most authentic for the thermal expansion of silica minerals. Other investigators have reported data on the thermal expansion of silica brick and its components, but in nearly all cases European brick were examined. The data on American silica brick are rather limited.

With such an object in view a rather complete study was made. Although basic information as to the expansion and transversion points of silica minerals is well established, it would not be feasible to assume that these data would indicate what the expansion of a brick would be since it is composed of an undetermined amount of quartz, cristobalite, tridymite, calcium silicate glass, and small quantities of aluminium and iron silicates.

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Refractories Division).

[2] Industrial Fellow, The Koppers Company Laboratories, Mellon Institute, Pittsburgh, Pa.

[3] For these references and others see Bibliography at end of paper, pp. 445–46.

Method Employed

The apparatus used for the determination of the thermal expansion was a modification of that of Houldsworth and Cobb and that of the Bureau of Standards. Figure 1 shows the general design which consists of a

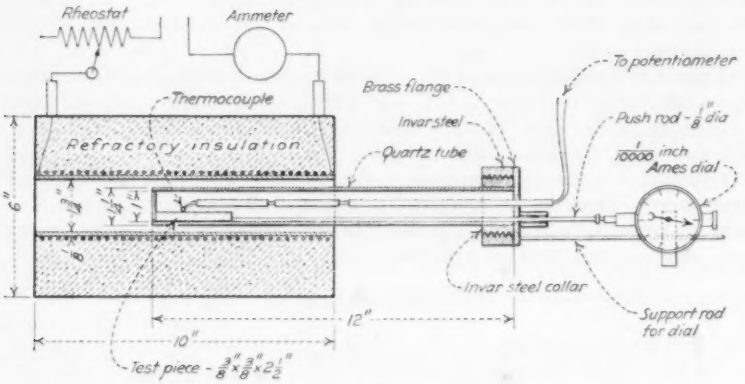


FIG. 1.

quartz glass tube having one end closed with a flat piece of quartz glass. A collar of invar steel was fastened to the open end with a cold setting cement. Into this collar or ring, a rod was inserted which supported an 0.0001 inch Ames dial. The brass plate and sleeve served to keep the

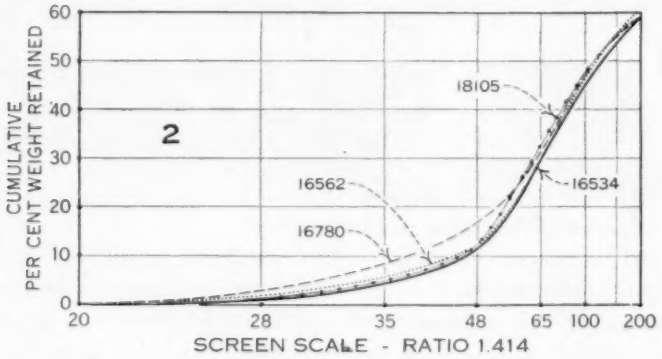


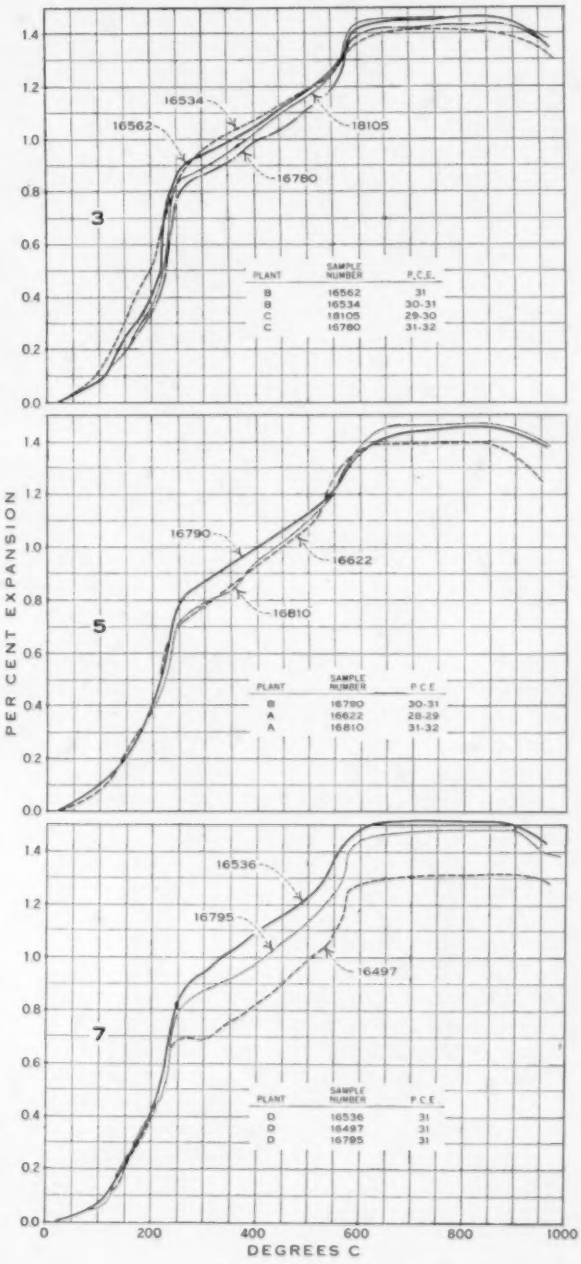
FIG. 2.

quartz glass push rod in a horizontal position. This rod served as the moving member, being in contact with the test piece and the Ames dial.

Test pieces, measuring approximately $^3/_8$ inch square by $2^1/_2$ inches long were cut from the brick with a cutting-off wheel. The mortars were

molded into test bars of similar size using a 5% dextrine solution for a wetting agent. All bars were measured with a micrometer caliper before testing. The heating was accomplished by means of a nichrome wound tube furnace. The temperature was maintained at each point until no further expansion occurred. Data readings were obtained at these points: 70°, 90°, 110°, 120°, 140°, 160°, 170°, 190°, 200°, 220°, 240°, 260°, 280°, 300°, 350°, 400°, 450°, 500°, 540°, 550°, 560°, 570°, 580°, 600°, 650°, 700°, 750°, 800°, 850°, 900°, 950°C. The expansion was corrected for the expansion of the quartz glass according to the data published by Souder and Hidnert.

The accuracy of this equipment is in the order of ±0.005% for any point. In fact data obtained on two samples from the same brick produced curves which overlay each other so closely that it was often impossible to differentiate between them.



FIGS. 3, 5, AND 7.

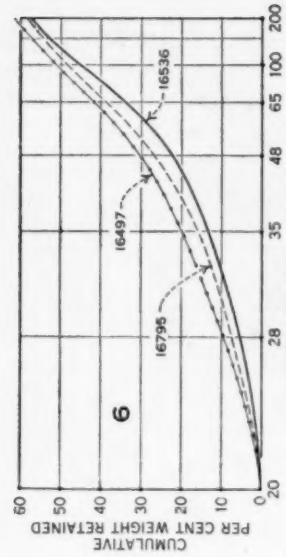


FIG. 6.

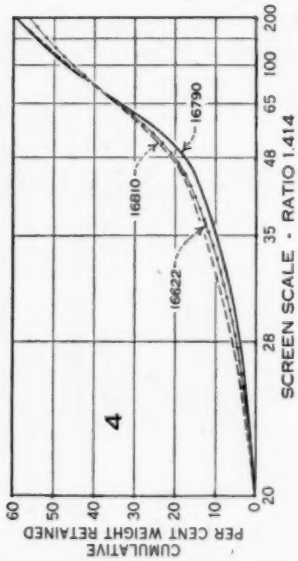


FIG. 4.

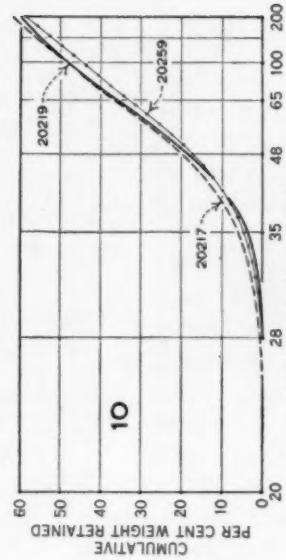


FIG. 10.

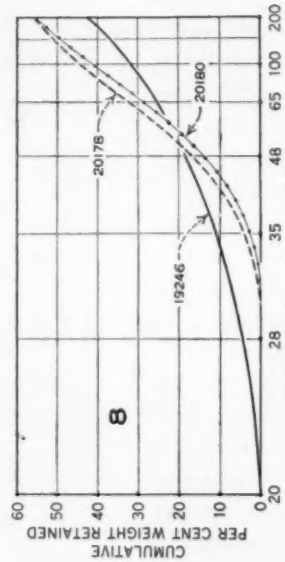
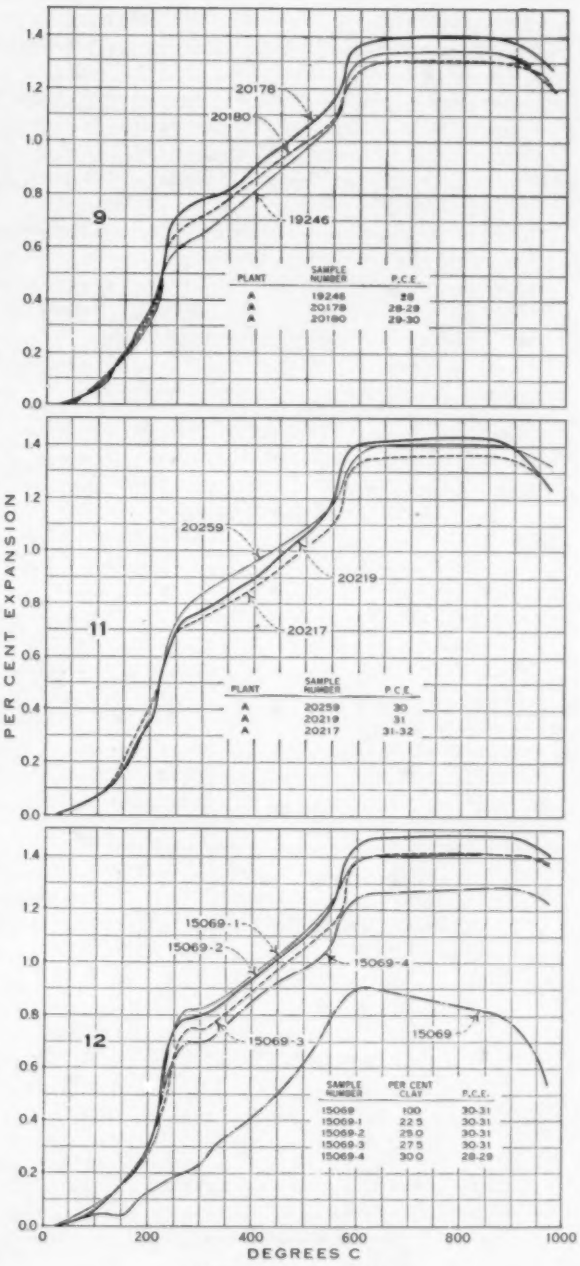


FIG. 8.

Data Obtained

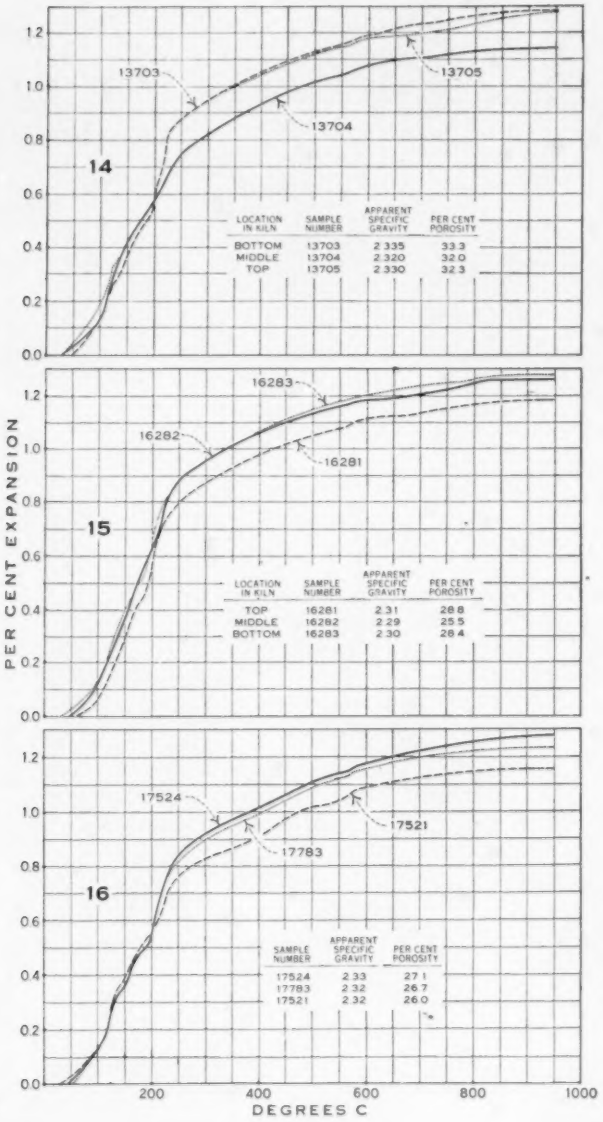
Since the data obtained would tend to be unwieldy if tabulated, it was deemed advisable to give this information in the form of curves which readily show differences found in the samples tested. The data divide into two parts, *e.g.*, that of silica mortars and that of silica brick.

(A) Silica Mortars The mortars, except for data shown by Fig. 12, were regular run-of-plant samples from four different plants: Screen analysis, P. C. E., and the thermal expansion are reported herein. A siliceous clay containing approximately 70% SiO_2 from central Pennsylvania was used in compounding the mortars. The variations in expansion data for mortars from various plants and of varied screen size and P. C. E. are shown by Figs. 3, 5, and 7. The screen analysis curves are shown by Figs. 2, 4, and 6. In these mortars the material passing a 200-mesh screen is nearly constant, the variation being in the



FIGS. 9, 11, AND 12.

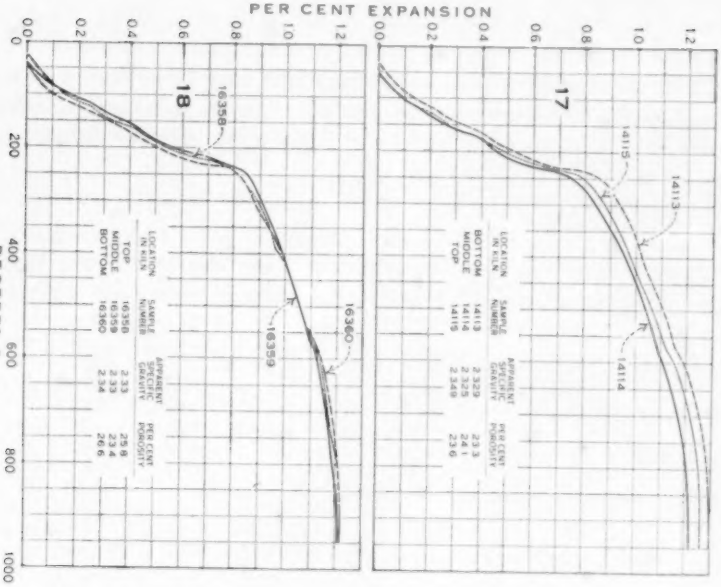
amount retained on 48-mesh and 100-mesh sizes. All mortars except 16497 show over 1.4% expansion at 700 to 800°C, while the amount of shrinkage varies from 0.03 to 0.18%. From these curves the size of grain appears to have very slight effect.


PER CENT EXPANSION
DEGREES C
14
13703
13704
13705
LOCATION IN KILN | SAMPLE NUMBER | APPARENT SPECIFIC GRAVITY | PER CENT POROSITY
BOTTOM | 13703 | 2.335 | 33.3
MIDDLE | 13704 | 2.320 | 32.0
TOP | 13705 | 2.330 | 32.3
15
16283
16282
16281
LOCATION IN KILN | SAMPLE NUMBER | APPARENT SPECIFIC GRAVITY | PER CENT POROSITY
TOP | 16281 | 2.31 | 28.8
MIDDLE | 16282 | 2.29 | 25.5
BOTTOM | 16283 | 2.30 | 28.4
16
17524
17783
17521
SAMPLE NUMBER | APPARENT SPECIFIC GRAVITY | PER CENT POROSITY
17524 | 2.33 | 27.1
17783 | 2.32 | 26.7
17521 | 2.32 | 26.0

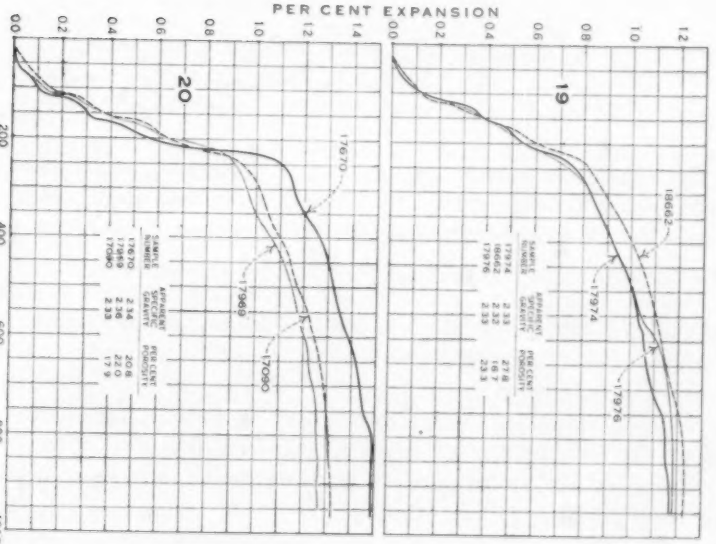
FIGS. 14, 15, AND 16.

The effect of variation in P. C. E. upon the thermal expansion is shown by Figs. 9 and 11. The screen analysis data are given on Figs. 8 and 10. The screen analyses, except on sample 19246, are very close and the expansion at 700 to 800°C varies from 1.30 to 1.43%. The P. C. E. variation is not the same as that of the expansion and does not lie in the same order.

The effect of various amounts of clay added to a constant screen size is shown by Fig. 12. The clay was added to sized aggregate of bats and quartzite, which produced a mortar having the following screen size for all samples: on 48-mesh, 20%; on 100-mesh, 25%; on 200-mesh, 15%; through 200-mesh, 40%.



FIGS. 17 AND 18.



FIGS. 19 AND 20.

The amount of clay or rather variations in quantity of the clay, the amount of bats, and the amount of quartzite seem to be the underlying cause for variations occurring in the thermal expansion of a mortar. These are difficult to control and such variations may be expected to continue. The P. C. E. may vary due to size of grain as has been shown by the writer in a previous paper[4] and will not always indicate variations due to clay content.

(B) Silica Brick The silica brick examined were regular run-of-plant material and the data herein reported are typical of those obtained in the investigation. In addition to the thermal expansion, apparent specific gravity and porosity values are reported.

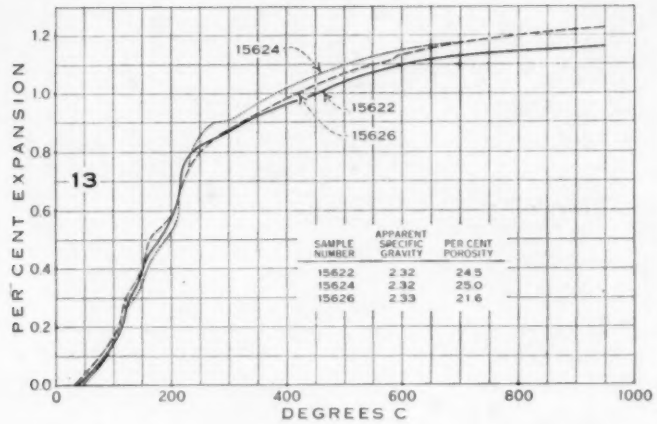


FIG. 13.

The expansion of brick made from Mt. Union, Water St., and Baraboo quartzites is shown by Fig. 13. These brick were fired together in the same kiln. Number 15626 was found to contain some unconverted quartz on petrographic examination as is shown by the anomaly at 575°C.

Figures 14, 15, 16, 17, and 18 are the curves for brick from the main producing districts and vary between 1.15% and 1.30% expansion at 950°C. The presence of quartz is well shown at 575 to 600°C. The variations in expansion are probably due to varying amounts of tridymite and cristobalite occurring in the brick coming from a kiln. The porosity appears to have little or no effect on the expansion.

Figures 19 and 20 are of brick from six plants in Europe and represent the main producing units. Except for 17670, the data are in close agreement with those of American brick. Several of these brick are made from

[4] S. S. Cole, "Effect of Size of Grain upon the Properties of Silica Cement," *Jour. Amer. Ceram. Soc.*, **10** [8], 643–50 (1927).

amorphous quartzites which are quite different in physical behavior, appearance, and properties from the American crystalline rock.

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THE PHYSICAL PROPERTIES OF THE FINENESS FRACTIONS OF SLAKED SEMIFLINT CLAY[1]

By M. E. Holmes[2] and A. J. Paul[3]

ABSTRACT

A select sample of Missouri semiflint clay was slaked to its natural size of grain and screened into the following sizes: on 20, 20 to 40, 40 to 60, 60 to 100, and through 100-mesh.

The 100-mesh fraction is a very dense firing clay, giving a high dry and fired modulus of rupture, and would be effective as a "dope" for a weak clay. The properties of the intermediate finenesses are substantially an average of the properties of all the finenesses. Points of inferiority in the coarse fractions are supplemented by points of superiority in the fine fractions, and vice versa. All fractions are therefore desirable, and further, there are indications that no substantial improvement could be made by screening out any one of the fractions.

Introduction

Semiflint clays, such as those found in Missouri, will rapidly slake into a series of grain sizes ranging in size from $^1/_4$ inch or more to colloidal, or near colloidal, dimensions. In most pits the slaking characteristics of the clay, as well as other characteristics, show much variation from place to place, even within short distances. The slaking characteristics, particularly the percentage of very coarse grains, are frequently used by manufacturers in the selection of the clay, and such defects as bench marking, cracking, etc., are frequently attributed in part to the clay having a deficiency of the coarse grains.

In view of the great importance of semiflint clay, it seems desirable to record the properties of the various fractions and to determine the extent to which the properties of the finished brick are determined by any one or more of the fineness fractions. The question also arises as to whether the quality of the brick can be improved by the elimination of any one of the fineness fractions and whether any fineness fraction constitutes a clay in itself of value for use alone or as addition agent in other ceramic mixes. A survey of the literature revealed no information on the subject.

Experiment A

A select sample of 100 pounds of Missouri semiflint clay, quite free of pyrite or other coarse-grained impurities, was prepared by crushing to a maximum size of about 2 inches and slaking by supporting the clay on a $2^1/_2$-mesh screen in a large excess of water. The entire sample slaked and passed through the screen in 5 minutes. To prevent caking the fine slip

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Refractories Division).

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portion was decanted from the coarser grains and screened wet. The coarser portion was dried and screened dry. Corresponding fineness fractions obtained in the two screenings were then combined.

The yield of the various fineness fractions is given in Table I.

TABLE I

Mesh	(%)
On 20-mesh	18.8
20–40-mesh	34.9
40–60-mesh	17.5
60–100-mesh	8.4
Through 100-mesh	20.5

The +20-mesh fraction contained a large percentage of sizes as large as $^3/_{16}$ inch.

The clay rapidly slakes into the fineness fractions given, and undergoes no further slaking of any consequence except on long continued contact with water. It could be expected, therefore, that dry pan tempering would yield fineness fractions somewhat in accordance with the figures of Table I, in that a clay yielding a high percentage of very coarse grains in slaking would yield a high percentage of coarse grains in dry pan tempering. The readiness with which the clay slakes into a series of grain sizes may be the reason why the wet pan may be dispensed with, as is frequently done in commercial practice, and satisfactory tempering obtained with the dry pan.

For determining the relation of each fineness fraction to the properties of the dried and fired product, a series of test bars were made in which each fineness fraction was successively eliminated. The specifications for each lot are given in Table II.

TABLE II

Lot 1	contains all sizes except	+20-mesh
Lot 2	" " " "	20–40-mesh
Lot 3	" " " "	40–60-mesh
Lot 4	" " " "	60–100-mesh
Lot 5	" " " "	Through 100-mesh
Lot 6	" " " mixed in the original proportions	

Lot 6 represents the semiflint clay as it comes from the pit, no elimination of any fineness fraction being made. Lot 1 differs from 6 in that the +20-mesh fraction is removed, it being 18.8% of the whole. Lot 2 differs from 6 in that all the 20- to 40-mesh, and that size only, is removed, the amount being 34.9% of the whole. Similar explanations apply to the other lots.

These bars were tempered by hand to the wetness given in Table III, and dry pressed with a hand-screw press into bars 1 x 1 x 7 inches.

They were then dried at 110°C and fired to cone 14 in 14 hours in an oil-fired downdraft kiln.

The properties of the bars in the dry and fired conditions are given in Table III.

TABLE III

Lot	Fineness fraction omitted	Water	Volume drying shrinkage	Dry modulus of rupture	Volume firing shrinkage	Fired porosity	Fired modulus of rupture	Dry bulk specific gravity	Fired bulk specific gravity
		(%)	(%)		(%)	(%)			
1	On 20-mesh	8.77	1.93	296	19.02	6.34	3515	2.08	2.31
2	20–40-mesh	9.05	2.17	306	19.20	5.30	3141	2.09	2.33
3	40–60-mesh	9.04	2.30	249	18.70	6.07	3033	2.11	2.34
4	60–100-mesh	9.39	2.14	254	19.27	6.86	2896	2.10	2.34
5	Through 100-mesh	8.55	2.04	246	18.92	9.66	2840	2.09	2.30
6	None	9.41	2.24	227	18.62	6.39	3045	2.11	2.33

A firing behavior test was also made on specimens from each lot, the results being given in Fig. 1.

Discussion of the Results of Experiment A

The elimination of any one of the fineness fractions produces no effect of definite significance on the dry or fired bulk specific gravity or the per-

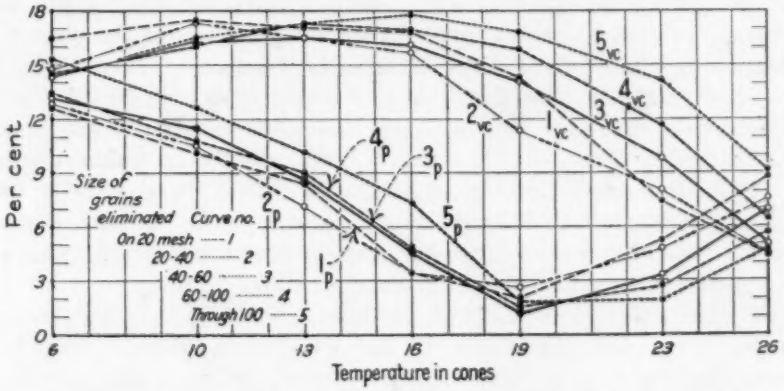

FIG. 1.—Firing behavior of semiflint clay with various fineness fractions eliminated. Note: Top five curves show volume change = vc; lower five curves show porosity = p.

centage of water required for tempering. The effects on shrinkage, modulus of rupture, and firing behavior are surprisingly small. Certainly not enough improvement in quality results from the elimination of any one fraction to justify doing so commercially. On the other hand, no one fineness can be considered essential, and the practice of judging the quality of the clay by the percentage of very coarse material is of doubtful

value. Inasmuch, however, as the properties grade rather uniformly from one end of the series to the other, we may infer that the elimination of two consecutive finenesses may have an important effect, although any one fineness fraction is a satisfactory substitute for the fraction next in size.

The elimination of the coarsest fraction does not result in excessively high shrinkage, cracking, low porosity, and high strength in the fired state as might be expected. The tendency, however, is in that direction and, as already stated, the elimination of the two coarsest fractions would likely produce results of magnitude.

The elimination of the fineness fraction does not result in excessively low shrinkage, high porosity, and low strength as might be expected, although the tendency is in that direction. The 60- to 100-mesh fraction meets all the requirements for developing a good bond and adequately substitutes for the through-100-mesh fraction in this respect. The elimination of the two fineness fractions, however, would likely produce effects of importance.

The firing behavior (Fig. 1), also shows a rather uniform gradation of properties from one end of the series to the other, the total differences being of some importance. The elimination of the through-100-mesh portions (curve 5) results in a considerably increased firing range and increased overfiring temperature. An advantage of two or three cones is evident over the lot from which the coarsest fractions are removed. It is evident that the through-100-mesh fraction is of considerably lower refractoriness than the other fractions and its elimination would result in considerably higher P.C.E. value. Owing to the fact that the 60- to 100-mesh fraction develops a satisfactory bond, it is evident that eliminating the through-100-mesh fraction would produce a brick of much improved quality for uses where low porosity is not necessary. A difference, however, of only about 2% porosity would result.

The elimination of 40- to 60-mesh material would produce no effect of consequence. The elimination of the on-20-mesh fraction, however, would result in a brick of lower refractoriness, greater density, perhaps greater resistance to slag action, and lower resistance to spalling, insofar as the two latter properties are dependent on density. It would, probably, reduce evidence of local checking due to differential shrinkage.

It is evident that semiflint brick of improved uniformity of quality could be made by slaking, screening into the various sizes, storing in separate bins, and admixing in constant amounts. Where the practice prevails of tempering to excess wetness followed by aging, the proposal might not be impracticable, but obviously it would not be adopted until the demands of the trade are more exacting.

Experiment B

For the purpose of making a more definite comparison of the properties of the various fractions, and of determining whether any one of the fractions constituted a clay of extraordinary quality, test bars were made of each of the fineness fractions separately. Another 100-lb. sample of the clay was slaked, as described under Experiment A. The yield of each of the fractions is given in Table IV.

TABLE IV

Mesh	(%)
On 20	17.3
20–40	32.7
40–60	15.3
60–100	10.2
Through 100	24.6

A comparison of the data of Tables IV and I shows that the slaking characteristics of different portions of the same lot of semiflint clay are quite constant and characteristic.

Each of the fractions was ground to through-100-mesh and dry-press bars made of each fraction individually. They were formed, dried, and fired as described under Experiment A. The identification of the lots is given in Table V.

TABLE V

Lot 7	contains only + 20-		mesh	grains	ground	to	pass	100-mesh		
Lot 8	"	"	20–40-	"	"	"	"	"	"	"
Lot 9	"	"	40–60-	"	"	"	"	"	"	"
Lot 10	"	"	60–100-	"	"	"	"	"	"	"
Lot 11	"	"	through 100-	"	"	not ground				

The results of the tests of the bars are given in Table VI.

TABLE VI

Lot	Fineness fraction	Water in bars (%)	Volume drying shrinkage (%)	Dry modulus of rupture	Volume firing shrinkage (%)	Fired porosity (%)	Fired modulus of rupture	Bulk density dry	Bulk density fired	Color
7	On 20	7.0	0.7	206	33.0	13.2	−200	1.75	2.30	Buff
8	20–40	7.1	0.8	224	30.7	12.2	1750	1.81	2.31	Buff
9	40–60	7.8	1.3	365	28.2	3.1	3723	1.93	2.37	Gray
10	60–100	8.2	1.7	442	29.2	1.6	3029	1.89	2.38	Gray
11	Through 100	7.8	1.5	427	27.3	0.8	4252	1.92	2.39	Gray

NOTE: 3 bars of Lot 7 cracked in firing. Two other bars were weak. One bar of Lot 8 cracked in firing.

As in the case of Experiment A, specimens from each lot were put through the regular firing behavior test. The results are given in Fig. 2.

Discussion of the Results of Experiment B

Although all fractions were put through 100-mesh, it is recognized that Lot 11 must contain somewhat more superfine material than the others, and that the differences in the properties of the lots of Table VI are to be attributed in part to this factor. A comparison of the various lots in general terms is possible.

The drying shrinkage, dry modulus of rupture, and fired modulus of rupture increase quite regularly from Lots 7 to 11, the increase being very

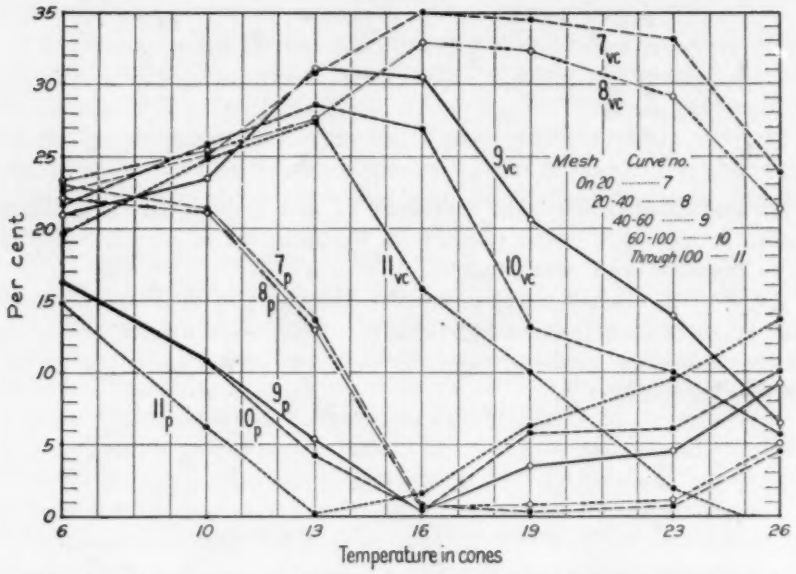

FIG. 2.—Firing behavior of fineness fractions of semiflint clay ground through 100-mesh. Note: Top five curves show volume change = vc; lower five curves show porosity = p.

large in the case of the modulus of rupture figures. The per cent firing shrinkage and the fired porosity decrease quite regularly through the series. Lot 7 (on 20-mesh) displays the characteristics of hard flint clay, and Lot 11 (through 100-mesh) displays the characteristics of plastic fire clay with a quite regular gradation between the two. Referring to Tables I and IV, it will be noted that the finenesses center around two sizes, the 20- to 40-mesh and the through-100-mesh, as though the clay consisted essentially of two materials. The firing characteristics would indicate that these two materials are similar to ordinary flint clay and plastic fire clay, respectively.

It is noteworthy that the intermediate Lot 9 shows average qualities in all respects, the properties grading away on one hand into the charac-

teristics of flint clay and on the other hand into the characteristics of plastic fire clay. The lack of bond in the coarser fractions is supplied by the finer fractions, and the extremely open texture of the coarser fractions is neutralized by the extremely dense texture of the finer fractions. The gradual gradation in properties, however, shows why any one fraction is a good substitute for the one next in size, as brought out in Experiment A.

The decided drop in porosity between Lots 8 and 9 without increase in shrinkage may be an indication of free Al_2O_3 in Lots 7 and 8, but this has not been checked by analysis.

The transition from the flint clay characteristics of the coarse fractions to plastic fire clay in the finer fractions is also apparent in the firing behavior curves (Fig. 2). The coarse fraction (on-20-mesh, Lot 7) gives a firing range of about 5 cones and an overfiring temperature of about cone 23 compared with an overfiring temperature of about cone 13 and a practically negligible firing range for the finest fraction (through-100-mesh, Lot 11). The curves for the other fractions occupy intermediate positions in quite even gradation. Although there is a transition in properties from Lot, 7 to 11, somewhat of a break occurs between Lots 8 and 9, Lots 7 and 8 having more distinctly the flint clay characteristics, and Lots 9, 10, and 11 having characteristics somewhat in common with plastic fire clay.

It is apparent that the fractions of intermediate fineness could be removed without altering the properties of the finished product which is borne out by the data of Table III. The removal of all the finer fractions or all the coarser fractions, however, would radically alter the character of the product. It is also apparent that this clay could be separated into two portions of very different properties, one coarse textured for resistance to spalling, and another fine textured for resistance to slag action.

The through-100-mesh fraction (Lot 11) is a very dense firing clay of high strength both in the dry and fired condition; while it is not of superquality in these respects, it would be an effective agent for some ceramic mixes requiring these qualities, and might be worth consideration in some cases because, as shown in Experiment A, it could be eliminated from the semiflint fire brick mix without materially impairing the quality of the brick.

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A SHOP METHOD FOR COMPARING SUBSIEVE PARTICLE DISTRIBUTION IN NONPLASTICS[1]

By M. H. Hunt

ABSTRACT

A sedimentation for determining subsieve particle distribution is described. The apparatus is simple and efficient enough to be used in shop practice. Curves obtained on feldspars and flints as well as other ceramic materials are shown.

Introduction

Feldspars and flints for use in ordinary body compositions today are ground to a degree of fineness such that over 90% of the material will pass through the finest standard sieves; consequently a screen analysis analyzes less than 10% of the material. This indicates that any judgment of fineness or behavior based entirely upon a screen analysis might not correctly represent the value of the particular material in a body composition. It has been noted, for instance, that a feldspar showing a rather large percentage of total residue on a 325-mesh screen may have a higher percentage of extremely fine particles than another feldspar showing a lesser residue on the same screen. On the other hand, many factory processes require that both the feldspar and the flint be reground before final incorporation in the bodies, and this grinding reduces the fineness to an extent which leaves only about 1% residue on a 325-mesh lawn.

The necessity and desirability of determining these extremely fine particles, either comparatively or quantitatively, has received no little attention in the past. A number of methods have been devised which in general have depended upon elutriation using either air or water, sedimentation,[2] or microscopic examination. The authors show how it is possible through the use of Stokes' law to determine the actual particle size distribution in a mixture. It is not the purpose here to arrive at a quantitative measure of the particle sizes, but simply to provide a rapid method for comparing them in successive shipments of such nonplastics as flint and feldspar, as well as for controlling grinding operations in the shop.

Description of Apparatus and Method of Operation

The apparatus described in this paper is not new in principle but is an adaptation of the sedimentation method devised by Wiegner.[3] It consists

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division).

[2] H. G. Schurecht, "Sedimentation as a Means of Classifying Fine Clay Particles," *Jour. Amer. Ceram. Soc.*, **4** [10], 812 (1921); E. Schramm and E. W. Scripture, Jr., "Particle Analysis of Clay by Sedimentation," *Jour. Amer. Ceram. Soc.*, **8** [4], 244 (1925); C. J. Van Nieuwenburg and W. Schoutens, "A New Apparatus for a Rapid Sedimentation Analysis," *Jour. Amer. Ceram. Soc.*, **11** [9], 696 (1928)

[3] *Landw. Versuchsstat*, **91**, 41 (1918).

(Fig. 1) of two glass tubes, connected about 15 cm. from the bottom, a millimeter scale to read the recession of the liquid in the small tube, an air connection for agitating the sample in the large tube, and suitable stop-cocks for operating.

The operation is as follows:

The two-way stop-cock, No. 2, is turned to connect tubes *A* and *B* and water is poured into tube *A* until it rises to a point about half way along the mm. scale on tube *B*. Tube *A* has a mark at this position, so it can always be filled to the same level. Stop-cock No. 1 is opened and the water drained out down to a definite mark about 50 cm. from the bottom of the tube. Fourteen grams of the dry sample are weighed out and placed in a beaker with water. This is then transferred to tube *A* with the use of a wash bottle and additional water is added to bring the level to the mark used in filling tube *B*. An air hose is then connected to the bottom of the tube *A* and the air turned on very slightly. Stop-cock No. 1 is opened and air is allowed to bubble up through tube *A* above. The extra height above the scale was provided to take care of the extra volume during this agitation period. At the close of the two-minute agitation stop-cock No. 1 is closed and stop-cock No. 2 is opened to the air momentarily to release a small pocket of air sometimes entrapped in the connecting tube. Stop-cock No. 2 is turned in position to connect tube *A* with tube *B*. At the moment of this connection the column of water in tube *B* is forced upward along the mm. scale due to the greater specific gravity of the suspension in tube *A*. A reading on the mm. scale is made as soon as equilibrium is reached which is a matter of a few seconds, and a stop-watch is started. Readings are taken every 15 seconds during the first few minutes of the test, as the coarser grains are falling rapidly and the water in tube *B* is receding rapidly. As the test proceeds, the readings can be taken at longer intervals. Sixty minutes is long enough for a test and for control work thirty minutes is satisfactory.

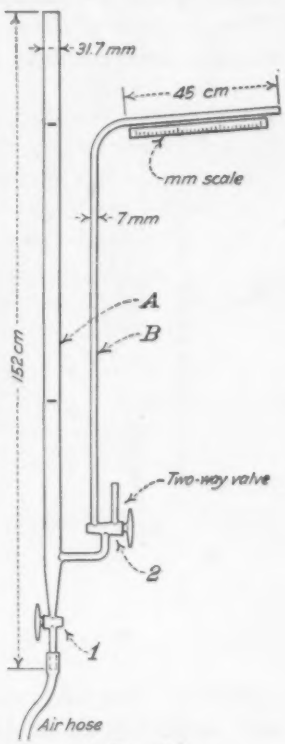

FIG. 1.

It is obvious that the curves thus drawn will represent fairly well the particle distribution in the samples. A sample containing a large amount of coarse material such as represented by the sample of andalusite (curve 5) will give a very rapid change in specific gravity in tube *A* as the material settles in the bottom of the tube. On the other hand, a fine sample such

as shown in curve 1 will settle much slower and show a less rapid specific gravity change in tube *A*. Undoubtedly curves 1, 2, 3, 7, and 8, representing material of very nearly the same specific gravity, should meet at a definite point if the test were continued long enough and all material actually settled out. Materials such as $BaCO_3$ and $CaCO_3$ as shown in curves 4 and 6 cannot be compared with the other materials shown because the agglomeration of particles causes settling much more rapidly than the actual fineness of these materials would indicate.

The accuracy of the apparatus in checking results obtained on any one sample or among various samples depends upon the standardization of the

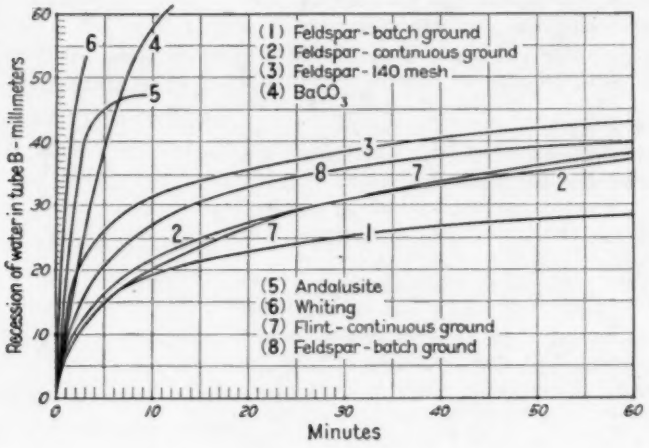

FIG. 2.

procedure. The tubes must be filled to the same points each time and the same amount of air bubbled through the tube. When these precautions are taken checks can be made to within 2 mm. total recession in tube *B* and the curves will be almost identical. If the material is agitated by alternately upending the apparatus, fairly close checks can be made when always using this method, but the results will not closely check with other methods of agitation.

Results

Figure 2 shows typical curves obtained on some ceramic materials when plotting time in minutes along the abscissa and the recession of the liquid in tube *B* along the ordinate. The following table gives the screen analysis of the materials used for the particular curves shown:

SCREEN ANALYSIS

Material % residue	Batch Ground Feldspar	Continuous Ground Feldspar	140-mesh Feldspar	BaCO	Andalusite	Whiting	Continuous Ground Flint	Batch Ground Feldspar
65-mesh		0.21	0.20	0.32	3.10		0.37	
100-mesh	0.07	0.20	2.05	0.14	0.17	0.02	0.27	0.04
150-mesh	0.19	0.70	5.95	0.14	10.70	0.04	0.57	0.15
200-mesh	0.60	1.40	4.65	0.10	7.70	0.07	1.19	0.75
260-mesh	1.67	2.20	7.57	0.12	6.82	0.15	2.42	3.80
325-mesh	2.59	4.10	6.75	0.12	6.52	0.35	4.15	10.27
	5.12	8.81	27.17	0.94	41.94	0.63	8.97	15.01
Curve	1	2	3	4	5	6	7	8

In general, we have noted less variation in continuous ground feldspar and flints than with batch ground, but the batch ground material usually shows a larger amount of fines. The slope of curves 1 and 8 (batch ground feldspar) after 30 minutes settling is less than curves 2 and 7 (continuous ground) indicating from their slower settling a larger amount of fines.

Acknowledgment The writer wishes to express his indebtedness to H. M. Kraner, Research Engineer, Westinghouse Electric & Mfg. Co., for his valuable assistance during the progress of this work.

WESTINGHOUSE ELECTRIC & MFG. CO.
DERRY, PA.

AN UNUSUAL KILN SCUM[1]

By H. B. Henderson

ABSTRACT

A heavy, white, fuzzy coating on brick developed in the firing. The coating consisted entirely of silica, produced from the reduction of silica and vaporized as silicon and re-oxidized.

Introduction

A thick, white, cotton-like coating on a brick product, was presented to this laboratory for classification and explanation of its occurrence. The coating, different from any we had ever seen, consisted of a large number of exceedingly fine hair-like tubes interlaced and matted on the surface of the brick.

Occurrence

The Brick The brick were made from a white-firing clay of secondary kaolin origin, which requires a high firing temperature.

The Kiln The firing was done in round downdraft kilns with natural gas as a fuel. The pyrometer readings were about 2300°F, but the brick undoubtedly were subjected to higher temperatures because of their place in the kiln setting.

Location in Kiln The coated brick were found around the bags, but not immediately facing them. Instead they were found two or three bricks back of the facing and extended to a depth of several brick.

Firing Conditions The coating occurs only in kilns firing a fire-flashed product in which the kiln atmosphere is strongly reducing. It did not occur in every flashed firing nor was it found around every bag in the kilns in which it occurred. The conditions necessary to develop this material were therefore quite limited.

Source

The gas company, as well as the factory operators, attributed the coating to something in the gas or developed from the gas in the process of combustion and deposited on the brick.

In two independent chemical analyses the material was reported as practically all silica.

The explanation of the coating presented here is that under strong reducing conditions with natural gas, which is chiefly methane gas, as the fuel, the hard graphite form of carbon is deposited in considerable quantity in the surface of the brick.[2]

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division).

[2] L. Bradshaw and W. Emery, *Trans. Ceram. Soc.* [Eng.], **21,** 117 (1921).

In the high temperatures some silica in the brick exposed to the flame was reduced by carbon to silicon and volatilized, then carried in the current of gases and deposited on the brick back of the facing of the bags. Whether oxidation to silica (SiO_2) occurs before the material is deposited or whether it is deposited as silicon (Si) and later oxidized during the flashing period is not known.

FIG. 1.—Photograph of brick covered by silica scum.

It follows that the coated brick will occur only in front of the furnaces where the temperatures are sufficiently high and the reducing conditions sufficiently active to reduce the silica. This accounts for the intermittent appearance of the coating.

When silicon-carbide crucibles are used in high temperature fusions a sub-limed silica deposit often occurs, but it is surprising that such a phenomenon could occur in a brick kiln.[3] It is not found on silica brick, which are fired at much higher temperatures than the facebrick product and under much more severe reducing conditions.

The observations made by this laboratory with silica brick firings are limited to those fired by coal. It may require a higher concentration of methane gas than is found in coal gas since methane gas is especially active in depositing the graphite form of carbon.

FIG. 2.—Photomicrograph of the scum.

On the other hand, it does

[3] It is surprising that such phenomenon should occur at the kiln temperatures normally attained in this instance, yet those who acquired their knowledge of how to fire natural gas in a brick kiln by experience are aware of the intense temperatures attained in the furnaces without getting the desired heat into the kiln chambers. Under such conditions it might be easy to get the temperature which it is assumed the coating will require.

not follow that the temperatures in the furnaces around the bags in the natural gas-fired kiln were not as high, perhaps higher, than the temperatures in a coal-fired furnace of the silica-brick kiln. The furnaces in the latter are really crude gas producers and the gas developed is burned among the brick in the kiln chamber. In the natural gas-fired furnace the combustion is largely completed to the limit of the air supply in the vicinity of the furnace with corresponding high temperatures, and the heat generated must be carried by convection to fire the ware.

Conclusion

The coating presented proved to be silica, very evidently the result of volatilization of silicon with subsequent deposition either before or after oxidation to silica. Modification of the firing to get less intense reducing conditions should avoid this difficulty.

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THE REACTIVITY TEST FOR DETERMINING THE VALUE OF BARIUM CARBONATE AS A SCUM PREVENTATIVE[1]

By A. Lee Bennett and H. R. Goodrich

ABSTRACT

A brief review of the causes of scumming and glaze peeling is given. The usual use of barium carbonate for the prevention of these defects is also outlined.

The reactivity test for barium carbonate and a suggested chemical analysis for soluble sulphates are described.

Reactivity values of various barium carbonates are reported, followed by a discussion of the practical value of the reactivity test. A specification for barium carbonate is recommended.

Introduction

Causes of Scumming and Glaze Peeling

All clays contain soluble inorganic materials. Necessarily the content of such salts is dependent upon the circumstances surrounding the formation of the clay and any subsequent treatment which it may have received. For these same reasons the soluble salt content of clays is an extremely variable quantity within the individual deposits, as well as from one deposit to another.

Architectural products may be rendered unsightly by reason of the formation of a discoloring film or scum of salts on the exposed surfaces of the ware, or in the case of products which are coated with a slip or glaze, the salts may cause a lack of cohesion between the body and the coating. This incoherence will frequently cause the slip or glaze to scale or peel from certain areas of the ware, leaving the bare body exposed, with consequent unsightliness.

Fortunately, the most highly soluble mineral salts, such as sodium chloride, are almost never found in clays in any appreciable quantities. One reason for this is that such very soluble materials are readily carried away by even small amounts of water. The more soluble salts are also usually very fusible, and because of this common property they are, in most cases, rendered incapable of causing any further scumming after the firing treatment. If it were not for these conditions, the highly soluble salts, especially the chlorides, would present a serious problem in ceramic bodies containing clay, since it is impractical to eliminate them in the usual manner by precipitating as insoluble salts.

It is with those salts which are rather insoluble or which dissolve but slowly with which we usually have to contend, the principal salt being calcium sulphate. The more soluble sulphates such as magnesium sulphate occur frequently. In general these materials are also quite refrac-

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Terra Cotta Division).

tory, and hence the firing treatment is not usually of any assistance in rendering them nonscumming.

Use of Barium Compounds Certain barium compounds, particularly barium carbonate, are used effectively in precipitating such sulphate salts. The barium carbonate reacts with these soluble salts, forming a carbonate and a sulphate salt as the end products of the reaction, both of which are so very insoluble as to be practically inert and harmless as far as the development of scum is concerned.

Various very soluble forms of barium such as the chloride and hydroxide are also used for precipitating soluble salts. Barium carbonate, however, is by far the most widely used precipitant because the more soluble barium compounds will themselves cause scumming if they happen to be present in a clay body in excess of the amount required to completely precipitate the soluble salts present. It is the usual practice when using these more soluble barium compounds to employ them in conjunction with barium carbonate with the proportions so adjusted that an excess of the more soluble barium compounds is never present.

Because of the extensive use of barium carbonate, any method of determining the fitness of a particular type as a precipitant of soluble salts under actual operating conditions should be of considerable value. This article describes the results of a study of a method of determining this particular property of a barium carbonate.

Reactivity Test for Barium Carbonate

Method Howat and Williams[2] have shown that different grades or brands of barium carbonate have a wide range of classification as determined by a laboratory reactivity test. The test used by them has been adopted for this study, and is conducted as follows:

> Weigh out 2 grams of barium carbonate sample and place in 100 ml. of 10% solution of magnesium sulphate. Allow to stand one hour at 70°F, stirring at 10-minute intervals with a glass rod. Filter and wash with water until no precipitate shows when tested with barium chloride. Wash precipitate consisting of barium sulphate and barium carbonate, which has remained unchanged, into a beaker and treat with dilute hydrochloric acid. Collect the barium sulphate now remaining by filtering and washing with warm water until the filtrate is free of barium chloride as shown by testing with a drop of sulphuric acid. Ignite and weigh. Correct this weight by subtracting the weight of barium carbonate sample which is insoluble in dilute hydrochloric acid. Convert the weight of barium sulphate into terms of barium carbonate ($BaSO_4$:$BaCO_3$::-233:197). This weight divided by the weight of the sample of barium carbonate taken times 100, equals the per cent of barium carbonate which has reacted with the magnesium sulphate.

With the above test it has been the experience of the authors that with different operators, or with slight variations in treatment, the resultant reactivities may vary as much as 4% with the same sample, although

[2] W. L. Howat and G. A. Williams, "Testing Barium Carbonate for Use in Terra Cotta Bodies," *Bull. Amer. Ceram. Soc.*, **2** [6], 161 (1923).

when two or more samples are run simultaneously the relative reactivities of the samples remain approximately the same. For this reason one brand of barium has been selected as a standard of comparison and this material is always tested along with the materials in question, for comparative values.

Suggestion for Soluble Sulphate Analysis

The soluble sulphate salt contents of the clays under consideration at the local factory have been found to range from 0.006 to 0.156% SO_3. For the purpose of developing a quick method of analysis for these soluble sulphates, the method of adding increasing quantities of dilute barium chloride solution to each of several graduates containing equal quantities of the water-suspended clay was tried.

A method adopted from a suggestion by H. G. Schurecht to the National Terra Cotta Society was tried, as follows:

> Add a 10-g. sample of clay to each of ten 100 ml. graduates and fill to the 100-ml. mark with distilled water. After thorough shaking add a solution of barium chloride of known concentration to each graduate in increasing quantities of from 0 to 9 ml., a ml. at a time. Make the suspensions acid by adding five drops of dilute hydrochloric acid (1 acid : 3 distilled water). Shake thoroughly and let stand until clear. To each graduate then add five drops of dilute sulphuric acid (1 acid : 3 distilled water). The graduates in which the water remains clear show an insufficiency of barium chloride. Those which become turbid show an excess of barium chloride, the turbidity being due to the precipitation of barium sulphate.

It was found in a study of the above test that the smallest increments of barium chloride solution that could be used to produce reliably discernible differences in sulphate contents were increments equivalent to 0.025% of SO_3. For quantities of sulphates greater than 0.1 equivalent of SO_3, this test therefore has good possibilities, and the results would probably lie within the range of variation in the sulphate content of any one clay. For lesser quantities the per cent of possible error becomes too great to be of much value other than a rough check of more exact analyses. Because of the inaccuracy of the test just described, the following method was adopted and is considered to be reasonably fast and precise, and simple enough to be conducted in the ordinary small laboratory.

Place 100 g. of the crushed material in a Pyrex flask containing 500 ml. of distilled water. Shake until all of the material is in complete suspension and repeat the shaking at intervals for 4 or 5 hours so that the more insoluble constituents may go into solution. Allow to stand until there is a sufficient amount of clear supernatant liquid for analysis. (With some clays it has been necessary to aid the settling with acid, in which case 50 drops of 25% formic acid, a sulphate- and chloride-free acid, was added.) For sulphates, filter an aliquot part to remove any possible suspended matter, wash the filter, and acidify the filtrate with HCl, heat to near boiling, and precipitate with 10% $BaCl_2$ solution. Filter hot and wash until no trace of $BaCl_2$ is left. Ignite and weigh as $BaSO_4$.

100-ml. portions were used for these analyses.

Reactivities of Various Barium Carbonates

TABLE I

BARIUM CARBONATE REACTIVITY VALUES

(Determined at 70 to 72 °F using 2.0-g. samples)

Sample No.	Description	Insoluble in dilute HCl (%)	Reactivity (%)
500	Imported precipitated	0.5	22.6
503	" "	0.9	22.4
504	" "	1.6	22.5
507	" "	0.2	22.6
508	" "	0.5	24.0
501	Domestic " ("technical")	2.3	20.6
502	" " "	2.2	22.1
505	" "	0.3	23.2
506	Natural ground witherite	4.2	8.9
511	" " "	5.7	10.8
510	" " " (extra fine)	4.8	11.5

Table I summarizes the results of a group of reactivity tests made on eleven different barium carbonate samples. It is found that the differences in the reactivities of the group of imported precipitated barium carbonates are inconsiderably small. The only commercial sample of a domestic grade of precipitated barium carbonate tested was Sample 505. As is shown in the table this was found to be as reactive as the average imported material. The domestic "Technical" grades were surprisingly high in insoluble material which resulted in a somewhat lower reactivity value.

A comparison of the precipitated barium carbonate against the ground witherites or natural barium carbonates discloses that the latter are only about one-half as reactive in this test.

In the matter of comparative costs, the natural barium carbonates could be purchased at a cost of about 85% of that of the precipitated barium carbonate at the local factory. Hence the precipitated barium carbonate is considered the cheaper. This latter condition is due to our location, and it is probable that a number of manufacturers might benefit in costs by the use of the natural ground product.

Practical Value of the Reactivity Test

Laboratory Tests

The foregoing results on the reactivity test indicate that the reactivities of commercial precipitated barium carbonates range from 22 to 24%. As a means of checking the practical value of these figures, several small batches of a terra cotta body containing 50% clay were prepared with increasing quantities of commercial barium carbonate and of barium chloride, respectively. These bodies were prepared by hand pugging, allowed to age for four days, and then pressed into small molds. The molded pieces contained a raised circular section and an inverted "V" section with an obtuse angle at the top of the "V," as it had been found that such faces were the ones which

tended to peel the worst in commercial practice. Half of the samples were air dried in about one week, the other half were dried for one day in air and then dried in a humidity drier on the second day. After being dried, the samples were coated with a terra cotta glaze over an underslip and fired in a commercial terra cotta kiln to cone 4 down. Testing of the matured glaze for adherence or for peeling tendencies was carried on by lightly chipping off the glaze with a cold chisel from all representative areas of the test pieces. Where the glaze could not be chipped off or separated from the body without taking off portions of the body with each fragment, the pieces were considered as being free from peeling tendencies. Those samples which possessed small areas only from which the glaze could be separated from the body with difficulty were classified as having developed "slight" peeling. Where peeling was evident on the samples as they came from the kiln, or where the glaze could be cleanly separated in large flakes, the samples were considered as having developed "bad" peeling. The term "medium" peeling was used to describe those samples whose peeling tendencies lay between the "slight" and "bad" peeling, or where clean-cut separations could be easily produced on only small areas.

TABLE II

COMPARATIVE EFFECTS OF BARIUM CARBONATE AND BARIUM CHLORIDE IN A TERRA COTTA BODY

Expt. No.	1	2	3	4	5	6
Barium carbonate added to mix (%)	0.0	0.25	0.5	0.575	0.65	0.75
Barium carbonate clay only (%)	0.0	0.50	1.0	1.15	1.30	1.50
Resultant peeling*	Bad	Medium	Slight to medium	Very slight to medium	None to slight	None
Expt. No.	**7**	**8**	**9**	**10**	**11**	**12**
Barium chloride added to mix (%)	0.05	0.1	0.15	0.2	0.26	0.50
Barium chloride of clay only (%)	0.10	0.2	0.30	0.4	0.52	1.00
Resultant peeling*	Bad	Medium	Slight to medium	None	Slight	Bad

* In Table II where only one description of results is given, the air-dried samples checked with those which were put through the humidity drier. Where a range of results occurred the humidity drier samples are reported first in each case.

The compositions of the mixes prepared and the resultant peeling tendencies have been assembled in Table II. It should further be noted that as a whole the air-dried samples checked well with those dried in the humidity drier. In a few cases, however, the air-dried samples developed a somewhat stronger tendency to peel and in such cases the range of peeling tendency has been noted. This condition was probably due to the slower drying which permitted more of the rather slowly soluble sulphate

salts to penetrate to the surface. Compositions numbered 4, 5, and 11 were not prepared with the original group of samples but were later added to narrow down the series. The same batch of clay and the same conditions of testing were used and compositions numbered 6 and 10 were rerun simultaneously as a check.

With reference to the comparative values of the carbonate and chloride forms of barium in preventing peeling, the results show that 0.75% of the carbonate are required to accomplish the same result as 0.2% of the chloride on a weight basis. This is equivalent to saying that one part of chloride is as effective as 3.75 parts of carbonate by weight. On the basis of barium (Ba) content, it is calculated from the above that 4.65 parts of barium in the carbonate form are required to equal the effect produced by 1.0 part of barium introduced in the chloride form. This relationship was calculated on a basis of 69.6% of barium (Ba) in barium carbonate ($BaCO_3$) and 56.2% of barium (Ba) in barium chloride ($BaCl_2 \cdot 2H_2O$). By considering the barium chloride as being 100% efficient or reactive, it may be concluded that the barium carbonate is therefore only about 21.5% as efficient or reactive as the barium chloride insofar as these tests are concerned.

It is realized that the above tests have not been narrowed down to small limits. This would be impractical, due to the obvious lack of exactness of the test itself. The value above is therefore approximate only, but serves to show that barium carbonate actually is effective or reactive to only a limited percentage of the weight used in practice. This percentage, while probably variable under different conditions of use, apparently lies approximately in the range of the reactivities as determined by the before-outlined reactivity test.

Commercial Results Some time ago the local terra cotta factory encountered a general condition of peeling occurring principally on glazed ware. This condition was found to be coincident with a change in the location of the mining developments at the pit from which the principal clay ingredient of the body was produced. This new location was found to produce a clay which was considerably darker than the original clay in the raw state, but which was practically identical in other properties such as plasticity, shrinkage, and in the resultant fired color. It was also found to be higher in soluble sulphate salt content.

As a corrective for this development of peeling the barium carbonate content was arbitrarily increased a certain amount. Several of such increases were necessary before a point was reached which definitely removed all tendencies of the glaze to peel. In the meantime, soluble sulphate analyses of the body ingredients were made to confirm our opinion definitely as to the cause.

By following these barium carbonate increases and checking them against

the analyses for soluble sulphates in all the materials concerned, it is possible to make some further deductions as to the efficiency or reactivity of the barium carbonate when used under certain commercial conditions.

The composition of the body in question is: 46.9% of the above-mentioned plastic clay, 9.5% of semiplastic material, and 43.6% of nonplastics, all on a dry basis. The amount of pugging water used is about 25% of the total body under normal conditions. Each of the above materials was analyzed for soluble sulphate content. It was found that the original supply of plastic clay contained quantities of sulphates ranging from 0.006 to 0.016% SO_3. The new clay was found to contain a much larger quantity of sulphates ranging from 0.080 to 0.156% of SO_3. The semiplastic material contained a fairly uniform amount with a maximum of 0.033% SO_3, while the nonplastics were practically free of sulphates, containing only a trace. A standard boiler analysis of the pugging water gave a value for SO_3 of 0.0032%.

Before the peeling trouble was encountered the standard quantity of barium being used amounted to 0.36% of the total body on a dry basis. The first increase was to 0.42%, the second to 0.60%, and the third increase which finally eliminated the peeling was to 0.75%.

Considering for the present the barium carbonate to be 100% efficient, the quantities of barium carbonate required to precipitate the sulphates from each component of the prepared body may be readily calculated. For 100 parts of dry body the maximum SO_3 content of the new plastic clay would require 0.181 part of barium carbonate.

$$SO_3 = 80,\ BaCO_3 = 197.4:\ 0.00156 \times \frac{197.4}{80} \times 46.9 \times 0.181.$$

Similarly the semiplastic material requires 0.008 part barium carbonate; the nonplastics require none; and the water requires 0.002 part barium carbonate. This gives a total of 0.191 part of barium carbonate required per 100 parts of dry body together with the necessary pugging water.

It was actually found that such a quantity of barium carbonate was not sufficient to precipitate all of the sulphates, and it was necessary to use 0.75% of barium carbonate as mentioned above in order to obtain satisfactory commercial results. This is 3.9 times as much as the theoretical quantity of 0.191%. In this case then it may be said that the barium carbonate was only about 25% efficient or reactive as calculated from the total quantity of sulphate salts present.

It is readily agreed, however, that the actual quantity of barium carbonate required to counteract this maximum content of sulphates might be closer to 0.6%, which was the quantity tried before the last increase was made, than to 0.75%. By using even this figure of 0.6%, it is found that providing this quantity was sufficient the barium carbonate would

have been about 32% efficient or reactive. We may then say that in this instance under commercial conditions the barium carbonate had an efficiency or reactivity of between 25 and 32%. This further leads us to the opinion that the laboratory reactivity test for barium carbonate gives results which are fairly comparable and within the range of results obtained in commercial application in a terra cotta body.

Barium Carbonate versus Barium Chloride

Barium chloride was compared with barium carbonate as a means of precipitating soluble sulphate salts, the results being reported in Table II. This material was selected as being typical of the more soluble barium compounds which possess good commercial possibilities when used in conjunction with barium carbonate. Such salts are more efficient and because of this may effect a saving in cost.

Comparative Costs In the following table the actual cost of barium carbonate as an agent in the precipitation of soluble salts is compared with that of barium chloride. The barium carbonate is considered as 25% reactive and the barium chloride as 100%. The cost per ton of the barium salts is that of January 1, 1930, at Los Angeles, Calif.

Chemical formula	Cost per ton	Barium (%)	Cost per ton of barium
Barium carbonate, $BaCO_3$	$68.50	69.6	$98.40
Barium chloride, $BaCl_2 \cdot 2H_2O$	90.00	56.2	160.10

Reactive (%)	Actual cost per ton of active barium
25	$393.60
100	160.10

On a basis of the results obtained by the writers, barium chloride costs less than one-half as much as barium carbonate. If but one-half of the theoretical quantity of barium chloride required to precipitate the soluble salts in a body is used in conjunction with one-half of the usual quantity of barium carbonate required on a basis of the cost of materials, it is possible to effect a saving of more than 25% of the cost of barium carbonate alone.

Safe Use of Barium Chloride As shown in Table II, a number of test batches were prepared with a view toward determining the quantity of barium chloride which can be used with safety. The barium chloride was added to the pugging water of the test mixes as a solution, and the quantity increased in increments of 0.1%, based on the clay content of the body.

It was found that any excess of the barium chloride comes to the surface of the body even though the quantity of chloride which has not reacted

is very small. Test pieces prepared from the various mixes and glazed, quickly revealed the presence of the barium chloride excess. With only a small excess present, but slight peeling developed as shown by Composition 11 given in Table II. When a large excess was added, very bad peeling developed as shown by composition 12 in Table II. In these as well as other test mixes, it was found that in every case where an excess of barium chloride was present, the glaze was but poorly knitted to the body, with the result that peeling occurred.

Inasmuch as a variation in the soluble salt content of clays must be expected, in the opinion of the writers, the practice of adding not over one-half of the quantity of barium chloride which would be required to precipitate the soluble salts in a clay body is to be recommended. An excess of barium carbonate should then be used in conjunction with the barium chloride to precipitate the remainder of the soluble salts.

If the character of the body ingredients is such that very little or no variation takes place in their content of soluble salts, or if such variations can be accurately determined in advance, the precaution of using considerably less than the theoretical quantity of barium chloride would of course be unnecessary.

Summary

The reactivity test for barium carbonate has been investigated in an experimental manner as well as under commercial conditions in the manufacture of a terra cotta body. It has been found to be indicative of the value of a barium carbonate as a soluble salt precipitant.

In the opinion of the writers, the reactivity of a barium carbonate should be used as the principal specification for determining its acceptability for the purpose of precipitating soluble salts. On a basis of numerous tests made on representative brands of both domestic and imported precipitated barium carbonates it is evident that a satisfactory material of this type should possess a reactivity of not less than 20.0%. A reactivity value of 22 to 23% or more is to be regarded as desirable.

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A PRACTICAL METHOD OF CONTROLLING THE QUARTZ CONTENT OF FELDSPAR[1]

By Joseph B. Shaw[2]

ABSTRACT

Free quartz in feldspar was determined by sampling, crushing to 4- to 10-mesh, separating the quartz grains from the feldspar by visual inspection, weighing each separately, and calculating the per cent of quartz. Bins having the different quartz content were blended before pulverizing to give a product of uniform composition.

Introduction

The free quartz content of feldspar has received much attention from different investigators. The influence of the variable constituents of whiteware bodies upon the finished product is appreciated and the necessity for accurate knowledge of the percentage of each constituent in the feldspar is imperative in order to maintain the high standard of quality necessitated by present day competition. As the deposits of better feldspar become exhausted and the feldspar producers are forced to use the high quartz pegmatites, the problem of controlling the free quartz content of the product will become really serious. Some of the feldspar producers have already found it necessary to segregate the feldspar into bins, and after chemical analysis, to blend them to obtain a uniform product.

Standard specifications and classification of feldspar on the basis of chemical composition adopted by the Feldspar Institute are certain to introduce problems not heretofore faced by feldspar grinders if they are to maintain their product within a given classification.

Suggested Inexpensive Method[3]

The procedure to be used is described as follows:

Two hundred grams of feldspar are crushed to pass through a 4-mesh screen, caught on a 10-mesh screen, and placed on a piece of black paper. The crushing has almost completely separated the quartz grains from the

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division).

[2] Head, Department of Ceramics, Pennsylvania State College.

[3] The process described here cannot displace the chemical analysis when absolute accuracy is needed. No claim is made for exact accuracy by this process. On the other hand, the time required for a complete chemical analysis of feldspar is of necessity two or three days by the best analysts. It is expensive and the accuracy of results must justify this item of cost. The process here described is extremely simple and requires less than one hour for the determination of the free quartz content of the sample.

Any high school boy can learn to manipulate a torsion balance or a chemical balance in a few minutes' time. The same boy can learn to distinguish grains of feldspar one-eighth inch across from similar sized grains of quartz by visual inspection. This process is based upon this knowledge.

feldspar grains. With tweezers the quartz is carefully picked from the feldspar, weighed, and the percentage of free quartz is calculated.

As an alternate method and check, the true specific gravity of the quartz, feldspar, and mixture should be determined. From these results the free quartz can be calculated by means of the following formula:

$$x = \frac{100(c - b)}{a - b}$$

a = true specific gravity quartz
b = true specific gravity feldspar
c = true specific gravity mixture

The formula is derived as follows:

Let x = % quartz by volume
$100 - x$ = % feldspar by volume
$ax + b(100 - x) = 100c$
$ax + 100b - bx = 100c$
$x(a - b) = 100(c - b)$

$$x = \frac{100(c - b)}{a - b} = \% \text{ quartz by volume}$$

$$\frac{ax}{c} = \% \text{ quartz by weight}$$

Experimental Work

To determine the accuracy of this method the feldspar as received at the mill in pieces from 3 inches to 3 feet in dimensions was reduced in jaw crushers to one-half inch maximum size. The crushed feldspar was delivered by bucket elevator and belt conveyer to a series of bins, each having a capacity of 450 pounds of crushed feldspar. A continuous sampler collected 50 pounds while filling each bin. The sample was run over a splitter giving a 5-pound sample. This 5-pound sample was crushed in a small laboratory jaw crusher to pass a 4-mesh screen. The size finally selected passed through a 4-mesh screen and was retained on a 10-mesh screen.[4]

The material which went through a 10-mesh screen contained about 10% more quartz than that which was retained on the 10-mesh. The data were found as follows:

Through 28-mesh, 39.24 grams; quartz not determined.
Through 14-mesh on 28-mesh, 29.56 grams; quartz, 26.62%.
Through 4-mesh on 14-mesh, 230 grams; quartz, 24%.

The difference in quartz content is 2.62%, or slightly over 10% of that found in the coarser material. This result was checked in a number of

[4] Obviously there is a limit to the size of grain that can be separated by hand. The material caught on a 10-mesh screen can be separated rapidly and without undue strain on the eyes and nerves. It was also found that crushing through a 4-mesh screen gave sufficient separation of the quartz and feldspar grains for practical purposes.

determinations. In practice, approximately 50% of the sample went through the 10-mesh screen, the other 50% being between 4- and 10-mesh. As a result of this observation and the fact that small particles of quartz adhered to some of the feldspar grains and could not therefore be separated led to the practice of adding 10% to the value actually determined for quartz content in each test.

Check by Chemical Analysis

Two bins of feldspar, 450 pounds each, were sampled in the manner described. The free quartz content of each was determined by the method described. A similar portion of each sample was ground in a mortar through a 200-mesh screen and complete chemical analysis was made.

The comparative results are given in the following table.

CHEMICAL ANALYSIS OF SEPARATE BINS AND PRODUCT RESULTING FROM BLENDING IN PROPORTION CALCULATED TO GIVE A PRODUCT CONTAINING 14% FREE QUARTZ

	Bin 1	Bin 2	Blend 450 lb. No. 1; 253 lb. No. 2 Calculated analysis	Blend Actual analysis of ground product
SiO_2	67.90%	73.15%	69.77%	70.60%
Al_2O_3	17.93	15.36	17.01	16.42
CaO	0.27	0.14	0.22	0.46
MgO	0.12	0.30	0.18	0.25
K_2O	10.90	9.55	10.42	10.22
Na_2O	2.48	2.03	2.31	2.02
Free quartz calculated from analysis	9.47	21.54	14.19	16.00
Free quartz found by test	8.25	24.00		

METHOD OF CALCULATING QUARTZ CONTENT FROM CHEMICAL ANALYSIS

	Chemical analysis		Combined Al_2O_3	Combined SiO_2
SiO_2	67.90			
Al_2O_3	17.93			
CaO	0.27 × 1.8	=	0.49	
	0.27 × 2.1	=		0.57
MgO	0.12 × 1.3 *	=	0.16	
	0.12 × 2.3	=		0.28
K_2O	10.90 × 1.09	=	11.88	
	10.90 × 3.83	=		41.75
Na_2O	2.48 × 1.65	=	4.09	
	2.48 × 5.80	=		14.38
			16.66	56.98

$17.93 - 16.66 = 1.27$ Al_2O_3 combined as $Al_2O_3 \cdot 2SiO_2$

$1.27 \times \frac{6}{5} = 1.52$ SiO_2 combined as $Al_2O_3 \cdot 2SiO_2$

$56.98 + 1.52 = 58.50$ total combined SiO_2

$67.90 - 58.50 = 9.40\%$ free quartz

Compared with 8.5% free quartz found by test

* Ratios in biotite mica. A. P. Honess, mineralogist, Pennsylvania State College, says that the only mineral likely to be present in feldspar carrying MgO would be biotite mica.

Blending Calculations

Several methods may be used for calculating blending mixtures. The algebraic solution is simple and is here illustrated.

Given Bin 1, free quartz	8.25%
Given Bin 2, free quartz	24.00%

Required to blend these two bins to give a feldspar with 14% free quartz.
Solution:

Let x = No. lbs. of Bin 1 per 100 lbs. of mix
$100 - x$ = No. lbs. of Bin 2 per 100 lbs. of mix

$$0.0825x + 0.24(100 - x) = 14.00$$

x = 63.5 lbs. Bin 1
$100 - x$ = 36.5 lbs. Bin 2

It was desired to blend these two bins in proper proportion to give a finished product having 14% free quartz content. These proportions calculated from the quartz content obtained by this test were 450 pounds of No. 1 plus 253 pounds of No. 2. Assuming the chemical analysis of the separate bins to be correct and the samples to be exactly representative of the material in the bins, the calculated analysis of the finished product would have been as shown under calculated result in the table and the product would have had a quartz content of 14.19%. Actual analysis of the finished product showed it to contain 16% free quartz. This variation of 2% indicates that the sampling may not have been accurate. The combined results of the table indicate that the desired result, that is, a 14% quartz product, was as nearly obtained by means of this test as would have been obtained by blending on the basis of complete chemical analysis.

The accuracy of this process was checked by carrying out this procedure in a number of cases. The free quartz content of samples from a number of different bins showing the variation of the material as it came from the quarry was as follows in percentages: 2.9, 3.5, 9.2, 26, 24, 13, 13.2, 11.7, 13.5, 16.5, 15.8, 18, 15.5, 6, 9, etc. These bins were blended, sometimes two, sometimes three times, in accordance with this data and in an effort to maintain a free quartz content of 14% from day to day. The chemical analysis of the finished product showed a variation from 13 to 16%. These figures indicate that the average composition of the product of this mill over a period of several days would run near 14%, but the composition from hour to hour and day to day would vary between 10 and 20%.

Effect of Free Quartz on Whiteware Products

Assuming the average feldspar content of whiteware bodies to be 25%, a feldspar with 10% free quartz would introduce 2.5% free quartz into the body. One with 20% free quartz would introduce 5%. The variation between 2.5 and 5% with its attendant variation in fluxing power of

the feldspar would undoubtedly introduce serious variations in the quality of the product and manufacturing difficulties. On the other hand, feldspar with 13% free quartz would introduce 3.25% free quartz into the body; one with 16% free quartz would introduce 4% into the body, a variation between 3.25% and 4%, or a variation of 0.75% quartz content in the body with its attendant small variation in fluxing power of the feldspar, while possibly producing recognizable differences in the quality of the finished product, would not seem to be a serious factor for the general run of white ware.

Recognizing the obvious fact that the quartz content can be slightly more accurately controlled by exact chemical analysis it is, nevertheless, doubted whether the accuracy thus obtained will justify the added expense over this admittedly less accurate but extremely simple and probably sufficiently accurate process.

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THE EFFECTS OF ADDITIONS OF ZINC OXIDE AND CADMIUM OXIDE ON SIMPLE GLASSES[1]

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ABSTRACT

The glass consisted of the composition SiO_2 58%, PbO 22%, and Na_2O 20%. Zinc oxide was introduced in increments of 5% up to a maximum of 20% as a substitute for equivalent parts of Na_2O. Similar substitutions were made with cadmium oxide. The following physical properties were studied: thermal expansions, solubilities in hydrochloric acid, indices of refraction, and annealing conduct. Analyses of the glasses were made. The suitability of these glasses as vitreous enamels is discussed. A vacuum electric furnace for melting and fining glass under reduced pressures is described.

I. Introduction

The exact chemical nature of glass is so little understood that the actual effect of each chemical compound present upon the physical properties of the glass cannot be stated. Quite useful and extensive work has been done, however, toward determining the effects of a number of the oxides which form the bases of the different glasses. Since even the simplest of commercial glasses is a substance of much chemical complexity, any attempt made to study the effect of a single oxide on a specific property is made difficult by the simultaneous effects on the other oxides that are also present. By the study of the individual oxides, many physical properties have been shown to be "additive," or at least approximately so. By an additive property is meant one which is dependent not only upon the oxides which the glass contains, but also upon the relative amounts of these which are present. The assumption that the properties are strictly additive accounts for much of the discrepancy between calculated and observed data. Commenting upon additive character, English, Turner, and Winks[4] explain the difference between the value of the physical constant calculated and its experimentally obtained value by the probable incorrectness of the figure attributed to the constituent in making the calculation.

II. Outline of Problem

Most glasses contain silica, the alkalis, one or more of the alkali-earths, and sometimes lead or boric oxide. The simple three-component glass

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Glass Division).

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[3] This paper was prepared from a thesis submitted by the junior author in partial fulfillment of the requirements for the degree of Master of Science in Ceramic Engineering in the Graduate School of the University of Illinois.

[4] S. English, W. E. S. Turner, and F. Winks, "Properties of Some Soda-Lead Oxide-Silica Glasses," *Jour. Soc. Glass Tech.*, **11**, 300 (1927).

upon which the investigation was based consisted of Na_2O–PbO–SiO_2. Andrews[5] investigated the entire field of compositions of the three-component system Na_2O–PbO–SiO_2 as to their suitability for enamels. A definite area was found within which the compositions possessed desirable properties. One of these compositions was selected as a basis for the present work.

Throughout, the PbO and SiO_2 contents were maintained constant. The Na_2O content was varied from 5 to 20% in steps of 5%. ZnO replaced the Na_2O in one series and CdO replaced the Na_2O in the second series, as

TABLE I

BATCH COMPOSITIONS

	Series Z (%)	Series C (%)
SiO_2	58	58
PbO	22	22
Na_2O	20–5	20–5
ZnO	0–15	
CdO		0–15

shown in Table I. It was found that when all the soda was replaced by either ZnO or CdO the batch was too refractory to melt at the temperatures used. The effect of varying ZnO and CdO contents was then determined on thermal expansion, refractive index, acid resistance, and solubility. The conduct of each of the compositions as a dry-process cast-iron enamel cover coat was also investigated.

The batch compositions only roughly approximate the final glass compositions. Selective volatilization of such compounds as zinc or lead oxide result in an appreciable loss of these oxides during melting. Molten glass attacks the containing vessel and results in the contamination of the metal by foreign substances, notably ferric oxide and alumina. Consequently, the batch composition cannot be relied upon; a chemical analysis must be made to determine the final composition of the prepared glass.

An additional problem that was undertaken as a part of this investigation was that of seeking a method of fining small glass batches. It was at first intended to make compressive strength tests on each glass. It was necessary, therefore, that the test pieces be free of bubbles and seed in order that the compressive strength values should have a real significance. It was also thought that if a practical method for fining small batches could be devised it would be of value to the glass research laboratory. Of late years, glasses have been demanded to fulfill very special requirements for optical purposes and other specialized uses. In many cases the viscosity of the metal is too high to permit the glass to fine itself. Con-

[5] A. I. Andrews, "A Study of Some Properties of Simple Enamel Glasses," *Jour. Amer. Ceram. Soc.*, **12**, 390 (1929).

sequently, if a clear glass must be had, large batches must be resorted to in order that fining agents might be employed. Under such circumstances work directed toward the study of the effects of elements that enter into any form of glass must be conducted on a very uneconomical basis. A method of fining small samples would eliminate this waste.

According to Peddle, the solubility of the glass can be lowered by equal proportioning of alkali between potassium and sodium. In the alkali $RO–SiO_2$ glasses, where RO is the oxide of either calcium or lead, when the total alkali is less than 20%, the glass containing both alkalis in equal proportion by weight will be less soluble and more durable than either the glass containing all the alkali as potassium oxide or all its alkali as sodium oxide. The RO may be represented by BaO, SrO, SnO, or MgO. The solubility of the glasses in water was found to decrease as the PbO or SiO_2 content was raised, but increased rapidly as the Na_2O was increased.

III. Methods Used in Investigation

A. The Fining Apparatus

All the plant practice methods of fining failed when applied to the small crucible batches. Specific methods tried were (*a*) temperature increase, (*b*) introduction of various solid fining agents, and (*c*) use of compressed air.

Fining can be accelerated but by no means completely accomplished by pushing the furnace to its extreme limit, the glass becoming increasingly fluid with higher temperatures. There are, however, two serious limitations to this method even in plant practice. Very high temperatures tend to change the chemical composition of the glass owing to an appreciable loss of certain constituents by selective volatilization. Where the chemical composition is so important from the point of view of attaining exactly the desired optical constants, these changes are liable to be of serious consequence. In some kinds of glass, moreover, the temperature must not be raised beyond a very definite limit, as higher temperatures result in ruining the color of the glass.

The use of a number of solid fining agents was tried, but in no case was a clear glass obtained. Such methods are effective in plant practice but were of little avail for laboratory work. Ammonium nitrate and a number of organic materials, such as raw potato and moist green wood were tried. Remelting of the glass after grinding was of no assistance.

Attempts to sweep out the bubbles by means of a stream of compressed air through a porcelain nozzle held below the glass surface also failed. The stream of air formed channels in the viscous melts through which the air rose to the surface.

All other methods having failed, it was then decided to try the effects of reduced pressures. An electrically heated vacuum furnace was then constructed. This furnace was similar to that used by Washburn, Footitt,

and Bunting in their determination of dissolved gases in glass. A number of changes had to be made and several mechanical difficulties overcome before any fined glass was obtained. Because of the presence of lead and zinc vapors, an unprotected platinum furnace winding and thermocouple could not be used. A chromel-alumel couple was tried but steam from the moisture present within the bell jar attacked the alumel, decomposing it. Consequently, the furnace temperature had to be determined by making blank runs. Since a predetermined heating curve was followed in each case and the temperature raised until the furnace burned out, a run using calcined clay in place of the glass gave the maximum attainable temperature. A platinum-platinum 10% rhodium thermocouple was used in making this determination. As a temperature between 1100°C and 1200°C was sufficient for fining the particular glasses it was possible to use chromel for the furnace winding.

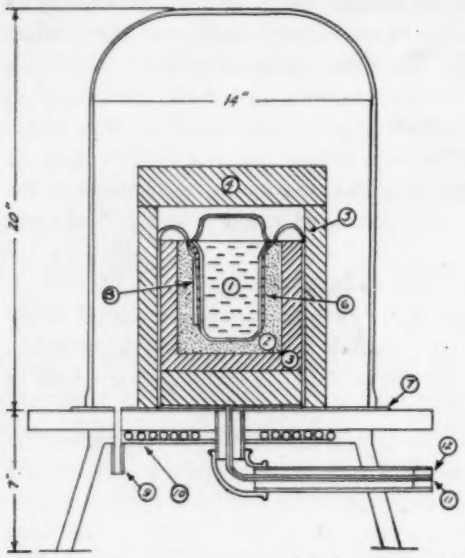

FIG. 1.—Vacuum furnace. (1) Crucible. (2) Sil-O-Cel insulation. (3) 6-in. round sagger. (4) Asbestos insulation. (5) Current supply leads. (6) Heating element. (7) Rubber gasket. (8) Thermocouple. (9) Vacuum pump connection. (10) Water-cooling coil. (11) Thermocouple and power leads. (12) Wax seal.

Figure 1 shows a cross-section view of the vacuum furnace. The furnace proper consisted of an Alundum crucible of about 800 cc. capacity. A coating of Alundum cement about $^1/_8$ inch thick was applied over the entire exterior of the crucible and while still moist a double spiral groove was cut in the cement to hold the furnace winding in place. When dried, the furnace was wound with sixteen feet of No. 18 chromel wire. A second protective coating of Alundum cement was then applied over the heating element and allowed to dry. The furnace was then embedded in a six-inch round sagger packed with powdered Sil-O-Cel. A new furnace was required for each melt as heating was continued until the furnace burned out and the glass was contained in the actual furnace core; the heating element was wound on the outside of the crucible containing the glass. This arrangement permitted a maximum temperature from the chromel resistance.

The vacuum furnace assembly and the details of the heating element and thermocouple installation are also shown in Fig. 1. A two-inch layer of asbestos separated the sagger containing the furnace from the water-cooled base. Thermocouple and heating element leads were then connected, care being taken that no short circuits occurred. The furnace was supported by an iron platform, soldered to the bottom of which was a copper cooling coil through which water was in constant circulation during a run. One of the two outlets through the base led to a Cenco Hy-Vac pump and the other contained the sealed-in current supply and thermocouple leads. Asbestos pipe covering was placed about the circumference of the sagger and several layers of asbestos paper provided additional insulation. After filling the crucible and covering with an Alundum lid, the top of the furnace was carefully insulated with sheet and fiber asbestos. Over this was placed the large Pyrex glass dome. A rubber gasket cemented to the iron base provided the seal between the bell jar and the base. Melted beeswax was applied about the circumference of the joint to insure an air-tight seal. Careful insulation of the furnace was necessary to prevent the melting of the rubber gasket or the softening of the wax seal. Even with the seemingly excessive amount of insulation, the glass dome became quite hot toward the end of each "run."

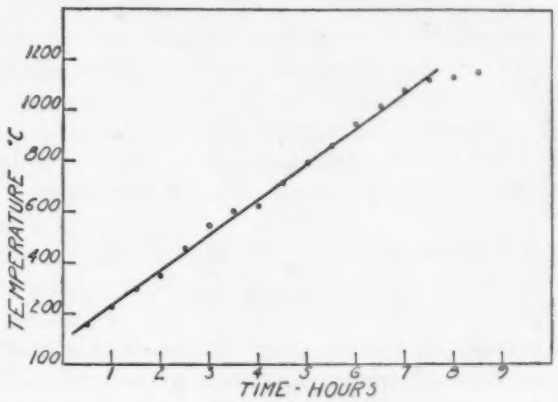

FIG. 2.—Heating schedule.

Experimental Procedure

The raw materials composing the glass were well mixed and smelted in crucibles heated in gas-fired pot furnaces. After coming to quiet fusion the smelt was quenched by pouring into cold water, after which it was dried and coarsely ground in porcelain ball mills. This first melting was purely preliminary and done only to increase the yield of glass from the vacuum furnace. The coarsely-ground glass was then remelted in the vacuum furnace.

The furnace, after being set up as previously described, was ready for a "run." The heating schedule and curve are shown in Fig. 2. The vacuum was maintained throughout the run. A manometer indicated the pressure within the dome. If much moisture was present in the asbestos, the vacuum was reduced by as much as 15 centimeters during the melting of

the glass. Ordinarily, a vacuum within 2 centimeters of mercury could be attained.

In every case, heating continued until the furnace burned out, as indicated by the ammeter. To reach this point required about ten hours, at which time the furnace was carrying ten amperes and the temperature was about 1200°C. The furnace was allowed to reach room temperature at its normal cooling rate. This rate was rapid enough to set up some strain in the glass, but usually the glass was not badly shattered. Figure 3 shows the vacuum furnace cooling curve. The properties of the glass were then determined.

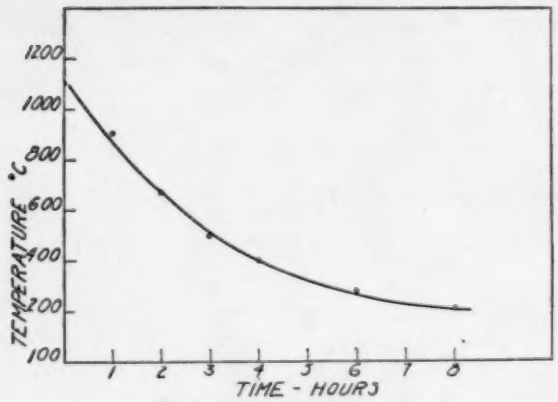

FIG. 3.—Cooling curve.

B. Expansion By using the interferometer method for determining the coefficient of thermal expansion a continuous record can be obtained from room temperature up to the softening point of the glass. The method is most accurate and the small size of the specimens employed simplified the problems of uniform heating and temperature control. Essentially, the interferometer expansion apparatus consists of a vertical electric furnace, the interferometer set-up, and a Pulfrich apparatus.[6]

C. Preparation of the Glasses Seven glass batches were made up, the base glass and three each with varying amounts of zinc oxide and cadmium oxide, respectively. The base glass was designated as A, the zinc series by Z, followed by a number denoting the batch percentage of zinc oxide; the cadmium series was similarly marked with the letter C.

The raw materials were accurately weighed, ground in a mortar, and screened through 40-mesh. The components were then thoroughly mixed on a sheet of paper by raising the corners and rolling the batch from side to side. The batch was then screened a second time to insure intimate mixing to facilitate the production of a homogeneous melt. The batches were melted in gas-fired frit furnaces. Melting required about four hours. With the exception of Z15C and C15 all the glasses were melted at a tem-

[6] G. E. Merritt, "Application of the Interferometer Measurements of the Thermal Dilatation of Ceramic Materials," Bur. Stand., *Sci. Paper*, No. 485 (1924).

perature of approximately 1300°C. The Z15 and C15 compositions required higher temperatures.

On coming to quiet fusion, the glasses were quenched by pouring in a fine stream into cold water. After drying, a portion of each batch was coarsely ground and remelted and fined in the vacuum furnace. The remainder of the frit was ground in porcelain ball mills to pass 100-mesh and used without further additions as a dry-process cast-iron enamel.

D. Solubility and Acid Resistance The durability of the glasses was determined by their acid resistance. A one-gram sample of 40 to 60-mesh grains was subjected to the action of constant boiling hydrochloric acid for three hours at 100°C. The solution was then filtered and the residue washed, dried, and reweighed. The loss in weight was calculated as per cent soluble.

This is admittedly not a rigorous test for solubility and is subject to error. Since, however, all the samples were prepared in the same manner, from similar series of approximately the same density, the results are comparable. Solubility is a function of the exposed surface; consequently a graded grain size was used. Further, if the glass were attacked and insoluble compounds formed, attack would not be shown by loss in weight. Results then would be too low.

The spot test consisted in placing a drop of 7% solution of citric acid on the surface of the finished enamel and allowing it to remain 15 minutes before washing off. The surface was then examined for evidence of attack.

E. Use of the Glasses as Enamels The suitability of the glasses as dry-process cast-iron enamels was investigated. The glass compositions used closely approximated those of simple enamel glasses without the addition of opacifiers. The enamels were applied by dusting the 100-mesh powder on hot cast iron on which a commercial ground coat had already been fired. The dusted pieces were then returned to the electric muffle furnace and melted down to as good a glass as was possible to obtain. The pieces were all fired for five minutes at 1500°F.

F. Index of Refraction The index of refraction was determined by the method of total reflection.[7] This method is based on the principle that light cannot always pass from an optically dense into an optically rarer medium but at a certain angle, known as the critical angle, will suffer total reflection. The critical angle for any substance varies with the index of refraction of that substance. This method is particularly useful because the measurement can be made upon a single polished surface, which may be quite small in area.

The measurement is made by means of an instrument known as a total refractometer. The essential feature of this instrument is a hemisphere of

[7] E. S. Dana, Textbook of Mineralogy, p. 219 (1921).

glass with a known high index of refraction. The upper surface of the hemisphere is plane and accurately adjusted in a horizontal position. The glass or mineral to be tested may be of any shape provided that some one surface upon it is ground plane and polished. A drop of some oil with an index of refraction intermediate between that of the glass hemisphere and the glass whose index is to be determined is placed between the surface of the hemisphere and the flat surface of the glass.

By means of a mirror, a beam of sodium light is thrown upon the hemisphere. At the critical angle for the combination of the two glasses (the effect of the oil film can be ignored) a shadow will appear in the field of vision. One side will be illuminated by the total reflection of all rays beyond those of the critical angle while the other side will be distinctly darker since here a considerable amount of the light passed out into the glass. As the index of refraction of the glass hemisphere is known, the index of the second glass can be calculated from the measured critical angle by use of the formula

$$n = \sin un'$$

where n is the unknown index, u, the critical angle measured, and n', the index of the atmosphere.

G. Chemical Analyses The melting and fining of a glass results in a material change in the composition as a result of crucible corrosion and selective volatilization. This was especially true with the present work because the glasses were twice melted and remained in the crucibles at high temperatures for long periods of time. The analyses are averages of duplicate determinations.

Silica was determined as SiO_2 by double precipitation of dehydrated silicic acid; lead as $PbSO_4$ in alcoholic solution; iron and alumina as combined R_2O_3; zinc volumetrically with standard $K_4Fe(CN)_6$; and cadmium as $CdSO_4$ after precipitation as the sulphide. Soda was determined by difference.

H. Annealing the Glass The presence of strain in glass is readily detected by means of polarized light, since strained glass exhibits double refraction to an extent which varies with the amount of strain present. When examined through crossed-nicol prisms, badly strained glass exhibits brilliantly colored patterns. Slightly strained glass shows dark and light patches, while thoroughly well-annealed glass shows only the slightest shading, and even this is absent in the best examples.

When dealing with glass and related materials, the introduction of permanent strains by rapid cooling or their removal and prevention to a considerable degree by annealing are not the only effects caused by these heat treatments. Several recent investigations have shown that by vary-

ing the heat treatment of glass appreciable changes in its physical properties, such as density, refractivity, and thermal expansion are produced.

The glass when taken from the vacuum furnace was not free from strain. It was consequently necessary to anneal pieces to be used for coefficient of expansion and index of refraction measurements. Specimens of each of the glasses were placed in a small electric furnace, heated to 625°C, and then cooled slowly through the critical annealing range. When reëxamined after cooling to room temperature, the samples showed no evidence of the presence of strain. Interferometer and index of refraction pieces were prepared from these samples.

V. Results

A. Description of Glasses

(1) All the batches yielded glasses with the first melting; Z15 and C15, however, were too refractory to melt at the maximum vacuum furnace temperature.

(2) All the glasses showed slight iron discoloration.

(3) The glasses did not all possess equal brilliance.

(4) All the glasses were not equally well fined. Both the Z series and the C series were more fluid than the base glass and consequently fined more readily.

(5) Refractoriness did not greatly increase until the percentages of zinc and cadmium oxide exceeded 10%.

B. Chemical Analyses of Glasses

The compositions of each of the glasses used in the investigation were obtained by making duplicate analyses. The results are shown in Table II together with the original batch compositions.

TABLE II

CHEMICAL ANALYSES OF GLASSES

	Composition by Analysis						Composition Calculated from the Batch				
Glass	SiO_2	PbO	R_2O_3	ZnO	CdO	Na_2O	SiO_2	PbO	ZnO	CdO	Na_2O
A	58.7	21.0	1.1			19.2	58.0	22.0			20.0
Z5	57.6	21.7	1.4	4.9		15.4	58.0	22.0	5.0		15.0
Z10	57.4	21.5	1.7	9.6		9.8	58.0	22.0	10.0		10.0
Z15	57.5	21.5	1.5	14.4		5.1	58.0	22.0	15.0		5.0
C5	57.5	21.4	0.9		4.7	15.5	58.0	22.0		5.0	15.0
C10	57.6	21.8	1.4		9.7	9.5	58.0	22.0		10.0	10.0
C15	57.8	21.6	1.3		14.6	4.7	58.0	22.0		15.0	5.0

In the case of glass A, introduction of the Na_2O entirely as sodium carbonate resulted in the separation of many small beads of metallic lead. Peddle[8] states that the separation of metallic lead can be prevented by replacing some of the carbonate with sodium nitrate. The loss of this lead accounts for the low lead content found by the chemical analysis.

C. Annealing

The method used for annealing the glass required for interferometer and index of refraction pieces was crude

[8] C. J. Peddle, "The Effects of Joint Presence of Sodium and Potassium on the Solubility of Lead Glasses," *Jour. Soc. Glass Tech.*, **5**, 195 (1921).

but gave the desired results. All that was wished was that the critical annealing temperature be exceeded, the strain removed and the glasses cooled again without reintroducing the stresses. The specimens annealed were not finished test pieces; consequently, slight deformation did not matter. The strain-free samples were then ready to be made into expansion and index pieces.

D. Heating Schedule Each run of the vacuum furnace was made using the heating schedule shown in Fig. 2. As previously stated, thermocouples could not be used when the actual glasses were being melted. The heating curve was obtained by making a blank run which continued for about eight hours before the furnace burned out while carrying a current of nine amperes. With some of the glasses the length of the runs was extended to eleven and twelve hours at which time the winding was carrying eleven amperes for a short period before burning out. It is not believed, however, that the actual temperature was any higher during these longer runs although a heavier current was being drawn. The length of chromel wire used in winding the furnace was not the same each time, and with the increased resistance, a greater current was required to produce the same temperature. A temperature of 1200°C is about the maximum attainable for chromel.

Table III shows the duration of each of the runs, the pressures in centimeters of mercury under which the glass was fined, and the condition of

TABLE III

RESULTS OF VACUUM FURNACE RUNS

Glass	Time (hours)	Height of Hg	Fining
A	13.0	60	Not complete
Z5	8.5	70	Complete
Z10	11.5	65	Complete
Z15	11.0	66	Only slight fusion
C5	9.5	64	Complete
C10	12.5	60	Nearly complete
C15	7.5	60	Only slight fusion

the resulting glass. It is probable that a much more rapid schedule of heating would have been possible, but such was not tried. Examination of the glass taken from incomplete runs showed fining well toward completion. A slower rate was used because the melting was conducted under reduced pressures. Glass contains quite appreciable volumes of dissolved gases, which, if liberated suddenly, would cause the glass to effervesce and flow from the crucible. A procedure involving rapid heating up to the point where the glass begins to soften, slow increase in temperature while the glass is softening, and again rapid after the gases have been largely liberated, would materially lessen the duration of the total melting and fining time and loss of lead and zinc due to volatilization.

E. Fining (1) Small batches of glass could not be fined by use of any of the methods employed in plant practice.

(2) Small batches of glass were fined under moderately high temperatures and under reduced pressure conditions.

(3) The high viscosity of the A glass prevented its complete fining.

(4) The zinc- and cadmium-containing glasses were much more fluid than the A glass and fined the more readily.

F. Use of the Glasses as Enamels (1) With the exceptions of Z15 and C15, all the glasses gave good vitreous enamel surfaces.

(2) Z15 and C15 were much too refractory to be considered as possible enamel glasses.

(3) Both zinc and cadmium oxides improved the gloss considerably and were equally good.

(4) The enamel glasses matured at moderately low temperatures.

(5) All the glasses were acid resistant as determined by the citric acid spot test. No evidence of attack could be found.

(6) Although the glasses were clear when first melted, all possessed varying degrees of opaqueness when used as enamels; A was the most opaque and Z10 and C10 the least. The C series was more opaque than the Z series. The opaqueness seemed to be due chiefly to minute air bubbles; Z10 being the most fluid, the bubbles more readily escaped from this glass.

(7) None of the glasses showed any crazing; one sample of Z10 chipped.

G. Solubility and Acid Resistance (1) The citric acid spot test showed no evidence of attack after 15 minutes in contact with the surface. The glass was unaffected.

(2) Replacing a part of the Na_2O with ZnO and CdO reduced the solubility of the simple Na_2O–PbO–SiO_2 glass from about 1 to $^1/_2$%.

(3) The following results were obtained with constant boiling hydrochloric acid at 100°C for three hours.

TABLE IV

SOLUBILITIES OF GLASSES

Glass	A	Z5	Z10	C5	C10
Per cent soluble	0.93	0.23	0.29	0.26	0.22

H. Indices of Refraction Glasses Z15 and C15 were too refractory to melt to clear glasses in the vacuum furnace; consequently their indices could not be determined. Table V shows the indices of refraction of the glasses.

TABLE V

INDICES OF REFRACTION

Glass	Critical angle	Index of refraction
A	59°20′	1.546
Z5	60°00′	1.557
Z10	60°35′	1.566
C5	60°20′	1.562
C10	60°45′	1.568

Replacing Na_2O by ZnO and CdO increased the indices of refraction. Cadmium oxide gave a higher index of refraction than an equal amount of zinc oxide.

I. Expansion (1) Additions of zinc oxide and cadmium oxide lower the thermal expansion of glass. The amounts of these decreases are shown in Fig. 4.

(2) That point in the expansion curve where there is a pronounced change in slope has been shown to correspond to the critical annealing temperature. Below this point the expansion bears a very nearly straight line relation to the temperature.

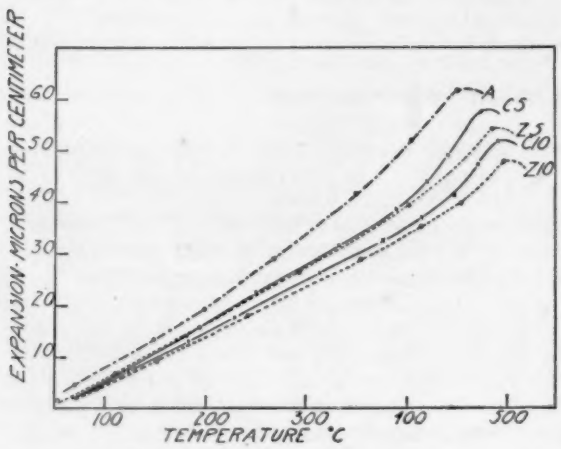

FIG. 4.—Glass expansion curves.

(3) The effects of zinc oxide and cadmium oxide on thermal expansion are very nearly equal up to the critical annealing temperature.

(4) Above the critical annealing temperature, the effect of zinc and cadmium on reducing the expansion is much more pronounced.

(5) The softening temperatures of the glasses as determined by the interferometer are given in Table VI.

TABLE VI

SOFTENING POINTS

Glass	A	Z5	Z10	C5	C10
°C	449	485	515	470	490

(6) Above the critical annealing temperature the rate of expansion increases considerably.

(7) The mean coefficients of expansion for temperature intervals of room temperature to 100°, 100 to 200°, 100 to 300°, 100 to 400°, and 400° to the softening temperature are given in Table VII.

TABLE VII

MEAN COEFFICIENTS OF EXPANSION ($\times 10^{-7}$)

Glass	R-100	100–200	100–300	100–400	100–470
A	406	410	476	526	456
Z5	313	366	384	398	451
Z10	324	310	318	342	365
C5	406	422	423	452	532
C10	265	348	356	356	404

(8) The expansion curves are shown plotted in Figure 4.

V. Summary

(1) The present plant methods of fining glass are unsuccessful when applied to small laboratory samples.

(2) By use of reduced pressures in a vacuum furnace it is possible to fine small batches of glass.

(3) The fined glass obtained from a vacuum furnace is "gas free"; that is, dissolved gases have been largely removed.

(4) Zinc and cadmium oxides are equally effective in increasing the acid resistance of a glass within the range studied.

(5) Both zinc and cadmium oxides lower the viscosities of the glasses.

(6) Up to 10%, zinc and cadmium oxide increase the refractoriness but slightly. Above 10%, the increase is much greater.

(7) The addition of zinc oxide makes a glass slightly more refractory.

(8) The expansion of glass above 100°C is quite as important as that at lower temperatures. The expansion of an enamel, for instance, should be in fairly close agreement with that of the iron at the temperature at which the glass becomes rigid after firing, as well as the temperature to which it may be subjected in use.

(9) That zinc and cadmium oxide should have very nearly the same effects on a glass is to be expected from their respective locations in the periodic table of the elements. The investigation bore this out.

(10) In the lower temperature ranges there is but a slight difference in the effects of zinc and cadmium oxides on expansion; in the higher temperature ranges, the differences become more pronounced.

(11) The rate of expansion is approximately linear only below the annealing temperature range.

(12) Above the annealing range temperature, the rate of expansion is much increased.

VI. Conclusions

(1) By means of reduced pressures it is possible to fine small batches of glass completely, provided the viscosity is not too great. Fined glass so obtained is "gas free." This investigation verifies Washburn's[9] statement that the use of a vacuum furnace eliminates entirely the fining operation as ordinarily understood, reduces the high finishing temperatures required for some glasses, and gives a product free from dissolved gases.

(2) That zinc and cadmium oxides should have very nearly the same effects on a glass is to be expected from their respective positions in the periodic table of the elements. In the lower temperature ranges there is but a slight difference in the effects of zinc and cadmium oxides on expansion; in the higher temperature ranges the differences become more pronounced. The rate of expansion is approximately linear only below the annealing temperature range.

(3) Up to amounts of 10%, zinc and cadmium oxides increase refractoriness of a glass but slightly. Above 10%, these oxides cease to act as fluxes, and greatly increase refractoriness and viscosity. Zinc oxide

[9] E. W. Washburn, F. F. Footitt, and E. N. Bunting, Univ. of Ill., Expt. Sta., *Bull.*, No. 118 (1920).

makes the melts slightly more refractory than an equal amount of cadmium oxide.

(4) Both zinc and cadmium oxides impart desirable properties to enamels. Without appreciably increasing the firing temperature, amounts of either zinc or cadmium oxide up to 10% can be added to enamel glasses. Within these limits, these oxides act as fluxes, decrease the viscosity, increase the acid resistance, and improve the appearance by giving a higher gloss. Thus, enamels having better working properties can be had if zinc or cadmium are used in the batch.

A SYSTEMATIC METHOD FOR THE INVESTIGATION OF SHEET-IRON ENAMELS[1]

By A. I. Andrews

ABSTRACT

A study was made of the compositions of twenty-four sheet-iron ground coats and twenty-four sheet-iron cover enamels. The results were plotted on triaxial diagrams and interpreted. Some laboratory results are given and the reading of triaxial diagrams is explained.

Introduction

The present paper does not offer new data but is an analysis and presentation of data selected from many sources. It is a study of the compositions of sheet-iron ground coats and sheet iron cover enamels.

Tables I and II show the compositions of twenty-four typical sheet iron ground coats and twenty-four sheet-iron cover enamels. The frit batches only are given, each having been calculated to total 100%. The average for each constituent of the enamels has been calculated and in the five columns in Tables IA and IIA the values for the maximum, minimum, average, median, and range, are given.

Along the bottom of each table the sum of the feldspar, borax, and flint is given for each enamel. This sum of the percentages of feldspar, borax, and flint for the ground coat compositions averages 82% and the cover coat enamels averages 72%. It is noteworthy that so large a proportion of the compositions is furnished by three constituents.

Sheet-Iron Ground Coats

Referring again to Table I, the maximum feldspar, flint, and borax is about 92% and the minimum is about 75%, but on careful observation it is evident that most of the values fall between 79 and 86% with many approaching close to 82%, which is the average.

On further analysis of this table it is noted that there are few constituents present other than the feldspar, flint, and borax. Soda ash and soda niter together average about 11% and seldom vary far from this value. The fluorspar varies infrequently far from 4 to 6%. From experience it seems doubtful if the cobalt oxide need ever vary greatly from the average of 0.5% or the manganese dioxide far from its average of 1.5%. Taking these values, a general batch can be considered about as follows:

Feldspar, Borax, Flint	82
Soda ash	7
Soda niter	4
Fluorspar	5
Cobalt oxide	0.5
Manganese dioxide	−1.5
	100.0

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division).

Although these values can be varied somewhat and good enamels obtained, the above might well be considered a base formula upon which all others could be built.

To simplify this batch further it is necessary to study the relative

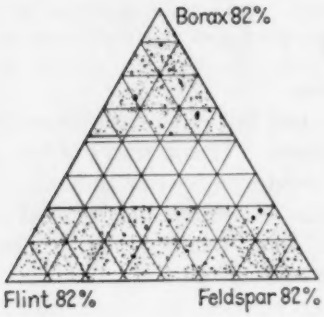

FIG. 1.

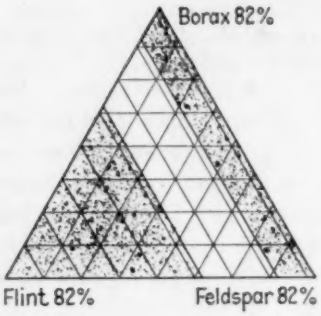

FIG. 2.

amounts of feldspar, borax, and flint which are permissible. This can be admirably done by resorting to Table I and plotting the results on a triaxial diagram.

The maximum and minimum feldspar are plotted on Fig. 1. The shaded portions show the fields of compositions not likely to give good enamels.

The maximum and minimum borax are plotted on Fig. 2. The shaded portion again shows the fields of compositions not likely to give good enamels.

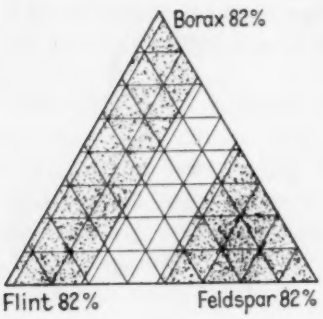

FIG. 3.

The maximum and minimum flint are plotted on Fig. 3. Again the shaded portion shows the fields of compositions not likely to give good enamels.

Figure 4 shows a diagram of Figs. 1, 2, and 3 superimposed on each other. In this diagram the shaded portion covers most of the area. The white area contains the only compositions showing promise of giving good enamels. The dotted lines show the averages of each constituent and their intersection shows the average feldspar, borax, and flint.

Since the area of good compositions is very small the possible limits of compositions of good ground coats must be comparatively narrow. It is highly probable that the great majority of the ground coats whose compositions are secretly guarded could be fit into this diagram.

It is true that small amounts of other constituents are used in some

TABLE I.—SHEET-IRON GROUND COATS

From Literature

	1 61	2 29A	3 29B	4 10	5 1	6 22	7 18A	8 18B	9 18C	10 62	11 81B	12 65A	13 65B
Feldspar	23.8	30.0	38.0	36.3	31.2	30.9	22.0	27.0	20.5	29.0	36.4	33.3	28.0
Borax	33.3	30.0	26.0	35.6	28.5	25.2	30.0	30.0	39.5	32.0	35.5	36.2	32.0
Flint	21.9	20.0	11.2	14.6	20.0	19.6	29.0	20.5	22.5	19.0	14.4	19.2	20.0
Soda ash		7.0	9.0	7.4	9.0	6.4	5.0	9.8	5.0	9.0	7.4	4.5	6.0
Soda nitrate	11.4	5.0	3.0		4.0	5.0	4.6	5.0	4.7	5.0		2.2	2.0
Fluorspar	4.2	6.0	7.0	5.3	6.0	7.5	6.0	6.0	6.0	4.7	4.6	3.7	3.0
Cryolite													8.3
Red lead													
Whiting			2.0										
Barium carbonate			2.0										
Clay	3.9												
Cobalt oxide	0.4	0.5	0.3	0.2	0.3	0.4	0.4	0.5	0.4	0.8	1.0	0.3	0.2
Manganese dioxide	0.7	1.5	0.7	0.6	1.0	5.0	2.0	1.2	1.0	0.5	0.7	0.6	0.5
Nickel oxide	0.4		0.2				1.0		0.4				
Copper oxide			0.6										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Feldspar, borax, and flint	79.0	80.0	75.2	86.5	79.7	76.7	81.0	77.5	82.5	80.0	86.3	88.7	80.0

	14 65C	15 65D	16 64	17 63A	18 63B	19 60A	20 8A	21 15A	22 15B	23 15C	24 15D
Feldspar	31.0	33.5	23.6	31.0	29.2	26.6	32.4	30.0	30.2	38.8	35.5
Borax	43.8	37.0	30.9	28.5	29.2	34.9	23.0	22.2	28.1	33.7	29.2
Flint	17.0	19.2	20.0	18.9	21.0	21.4	23.8	28.1	20.1	16.9	22.7
Soda ash	3.0	5.6	6.4	6.0	8.6	7.4	14.2	5.4	10.6	2.4	5.2
Soda nitrate	1.0		4.5	4.7	4.8	4.0	4.3	3.9	3.8	3.8	5.2
Fluorspar	4.0	3.9	5.4	6.7	3.8	3.5		5.0	6.0	2.3	
Cryolite					2.0						
Red lead											
Zinc oxide						2.2					
Whiting											
Barium carbonate	0.1	0.3	2.3	0.7	0.4		0.5	0.4	0.2	0.3	0.6
$MgCO_3$	0.1	0.5	5.4	3.5	0.6		2.0	4.0	1.0	1.0	1.6
Clay			1.5		0.4						
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Feldspar, borax, and flint	91.8	89.7	84.5	78.4	79.4	82.9	79.2	80.3	78.4	89.4	87.4

commercial ground coats but fundamentally they must be based on the above. Even though the total of feldspar, borax, and flint was varied the general trend of the field would remain constant.

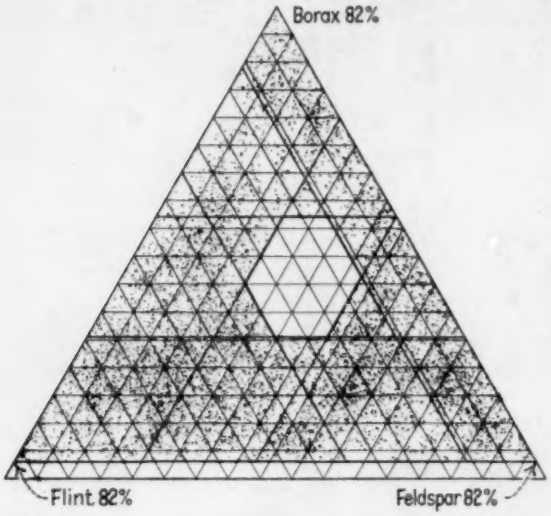

FIG. 4.

Sheet-Iron White Cover Enamels

The compositions of the white cover enamels and the results of the calculations shown in Table II can be plotted in a similar manner to that for the ground coats.

In this case, however, there is a greater chance for variation. More raw materials are used, opacifiers are employed, and the mill additions are larger.

As with the sheet-iron ground coats, however, this system of plotting offers an excellent procedure for investigation.

The feldspar, borax, and flint maximum and minimum values taken from the calculations of Table II are shown plotted on the diagram (Fig. 5.) This exact field has not been investigated but a similar one much simplified from the average of the 24 cover enamels was actually made up. This work was carried out by the class in enamels at the University of Illinois. The compositions are shown in Fig. 6. These enamels were all good, those in the center of the field investigated being the best. Numbers 5, 6, 9, 10, 11, 14, and 15 are very good compositions.

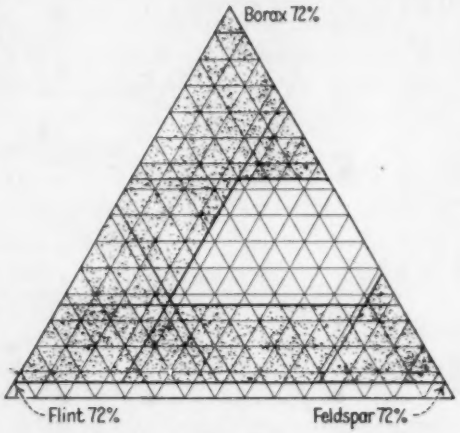

FIG. 5.

Triaxial Diagrams

To read a triaxial diagram several facts must be known. It is necessary to know:

(1) The compositions of the apexes (corners) of the triangle.
(2) The value of the divisions or cross-sections of the triangle.

If, as in most triaxial diagrams, each of the corners represents 100% of a single constituent the reading of the diagram is not difficult. In such a case the boundary lines represent all possible combinations of the constituents indicated at the adjacent corners and 0% of the constituent at the opposite corner. The area within the triangle represents all possible combinations of all three constituents.

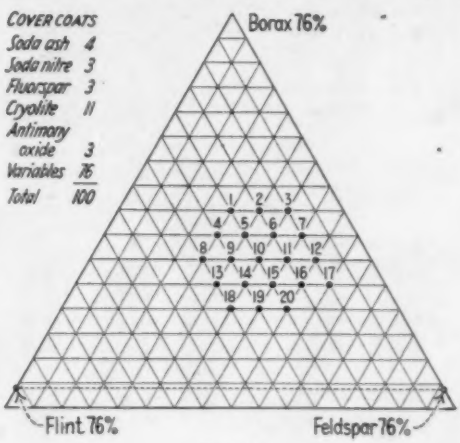

FIG. 6.

For illustration, refer to Fig. 7 in which the corners X, Y, and Z represent 100% of X, Y, and Z, respectively. Side XY represents all possible combinations of X and Y with no Z present. XZ represents all possible combinations of X and Z with no Y present. ZY represents all possible combinations of Z and Y with no X present.

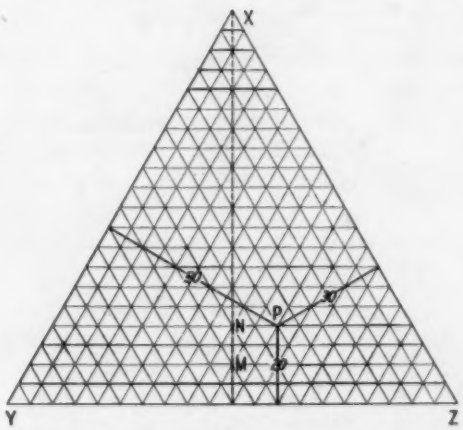

FIG. 7.

The vertical axis X, is put on the diagram to illustrate the method of reading the diagram. Points along the X axis increase in percentage of X from 0% at zero to 100% at X. At point M there is 10% of X; at N, 20% of X, etc. At P there is 20% of X and the same method can be used for each constituent. We read from the side opposite the constituent in question to the point for which the composition is required. Point P, therefore, represents 20% of X, 30% of Y, and

TABLE II.—SHEET STEEL COVERS

From Literature

	1 57	2 23	3 28	4 3	5 19A	6 19B	7 19C	8 24	9 56A	10 56B	11 11	12 67	13 69	14 70B
Feldspar	25.0	22.0	50.5	32.0	25.0	31.0	31.0	23.7	49.5	48.8	38.6	38.3	22.7	19.3
Borax	25.5	20.0	30.4	25.0	28.0	27.0	21.0	16.9	27.4	20.4	15.4	39.6	23.9	27.6
Flint	21.0	22.0		18.0	19.0	17.0	22.0	28.2			19.0		17.6	21.7
Soda ash	3.0	10.8		4.0	3.5	3.5	3.5	14.4	5.0	11.6		2.6	11.0	4.1
Soda nitrate	3.5	4.6	4.6	3.0	3.5	3.5	3.5	3.1	4.5	4.7	6.5	1.8	5.7	2.7
Fluorspar		2.6	4.4	4.0	5.0	5.0		5.0	4.1	4.3	1.3	0.1	10.1	6.2
Cryolite	14.0	5.0	10.1	12.0	12.0	12.0	17.0	6.2	9.5	10.2	11.7	12.7	4.5	9.5
Red lead														
Zinc oxide	5.0	5.0												4.8
Whiting											6.5			
Barium carbonate		4.0												
$MgCO_3$											1.0	0.1		
Clay												1.6		
Antimony oxide	3.0	4.0		2.0	4.0	1.0	2.0	2.5					4.5	4.1
Na antimony														
Opax														
SnO_2												3.2		
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Feldspar, borax, and flint...	71.5	64.0	80.9	75.0	72.0	75.0	74.0	68.8	76.9	69.2	73.0	77.0	64.2	68.6

	15 9A	16 82A	17 82B	18 82C	19 82D	20 66A	21 66C	22 66D	23 66E	24 66F
Feldspar	19.3	39.0	38.4	17.7	45.7	38.6	22.0	23.7	38.0	32.0
Borax	22.9	15.0	27.8	20.5	32.0	15.4	30.0	16.3	18.0	26.0
Flint	27.8	19.0	1.3	35.3		19.0	17.5	31.7	22.0	8.0
Soda ash	5.8		11.3	1.8	11.4		13.5	9.4		9.0
Soda nitrate		6.0	2.0	1.8	1.7	6.5	2.0	3.1	6.9	3.0
Fluorspar	6.9	1.0	5.3			1.3			2.2	6.0
Cryolite	15.6	12.0		19.4		11.7		15.8	12.9	5.0
Red lead										
Whiting	1.7									
Barium carbonate		7.0				6.5				
Clay										
Cobalt oxide		1.0		3.5		1.0				
Manganese dioxide										
Nickel oxide										
Copper oxide			13.9		9.2		15.0			11.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Feldspar, borax, and flint...	70.0	73.0	67.5	73.5	77.7	73.0	69.5	71.1	78.0	66.0

TABLE IA

	Max.	Min.	Av.	Med.	½	Range
Feldspar	38.8	20.5	30.3	30.9	29.65	18.3
Borax	43.8	22.2	31.6	30.45	33.0	21.6
Flint	29.0	11.2	20.0	26.0	20.1	17.8
Soda ash	14.2		6.7	6.4	7.1	14.2
Soda nitrate	11.4		3.8	4.2	5.7	11.4
Fluorspar	7.5		4.6	4.8	3.8	7.5
Cryolite	2.0		0.1		1.0	2.0
Red lead	8.3		0.3		4.2	8.3
Whiting	2.2		0.2		1.1	2.2
Barium carbonate	2.0		0.1		1.0	2.0
Clay	2.3		0.5	0.4	1.2	2.3
Cobalt oxide	5.4		1.5	1.0	2.7	5.4
Manganese dioxide	1.5		0.2		0.8	1.5
Feldspar, borax, and flint	91.8	75.2	82.3	80.0	83.5	16.6

TABLE IIA

	Max.	Min.	Av.	Med.	Range
Feldspar	50.5	17.7	32.2	31.5	32.8
Borax	39.6	15.0	23.8	24.4	24.6
Flint	35.3		16.1	19.0	35.3
Soda ash	14.4		5.8	4.05	14.4
Soda nitrate	6.9		3.7	3.5	6.9
Fluorspar	10.1		3.1	3.3	10.1
Cryolite	19.4		9.9	11.7	19.4
Red lead					
Zinc oxide	5.0		0.7		5.0
Whiting	7.0		0.8		7.0
Barium carbonate	4.0		0.2		4.0
$MgCO_3$	3.5		0.3		3.5
Clay	1.6		0.1		1.6
Antimony oxide	4.5		0.2		4.5
Na antimony					
Opax					
SnO_2	15.0		0.6		15.0
Feldspar, borax, and flint	80.9	64.0	72.5	72.5	16.9

50% of Z. The composition of any other point can be found in a similar manner.

In reading a triaxial diagram in which the apexes do not represent 100%, it is necessary to know what the actual composition of the apexes is and also the valuation of the divisions on the diagram.

In the type of diagram where each apex represents something other than 100% of one of the constituents the line opposite can be assumed to represent 0% of that particular constituent. Suppose

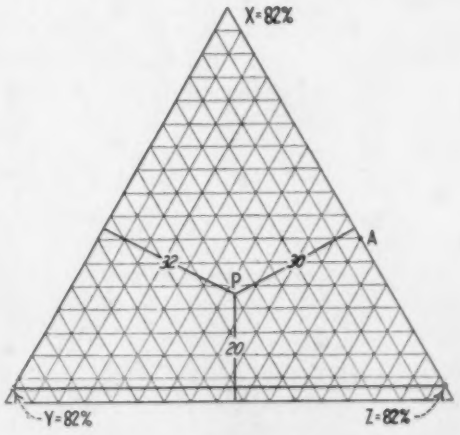

FIG. 8.

for illustration that the apexes of the triangle (Fig. 8) represent 82% of X, Y, and Z. This then is not unlike the diagram in Fig. 7 except that the total of X, Y, and Z in any case will add to 82% instead of 100%. Point P for illustration, contains 20% of X, 30% of Y, and 32% of Z. Point A would represent 32% of X, 50% of Z, and 0% of Y.

The third type of triaxial diagram found in the literature is the type where the apexes represent combinations of all three constituents. These diagrams are in reality parts of one of the former two types described.

Referring to Fig. 9, it will be noted that a triangle ABC is included in the XYZ triangle. The triangle ABC represents the third type. If appearing alone it would be as shown in Fig. 10. The XYZ values of the

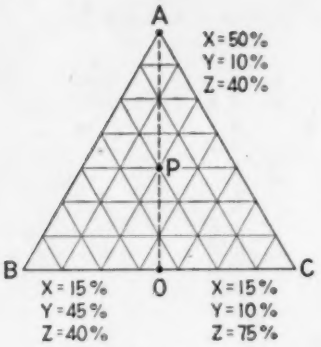

FIG. 9.

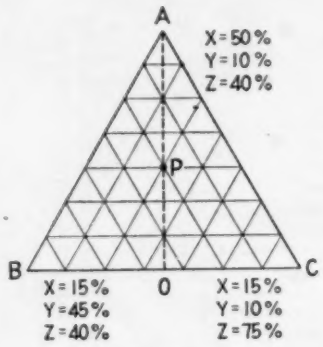

FIG. 10.

apexes of this triangle are indicated, having been read off of the diagram in Fig. 9.

To read this diagram (Fig. 10) the values of each constituent alone must be noted, thereby identifying the general trend of the field. For example, take the values of X. At A, $X = 50$; at B, $X = 15$; and at C, $X = 15$. Since X is greatest at A this corresponds with the X apex. Following through, the Y maximum will correspond with the B apex and the Z maximum will correspond with the C apex.

It will aid reading if X is underlined at the A apex, Y at the B apex, and Z at the C apex.

Having identified the apexes, the next thing to do is to identify the sides. A side is identified with the constants at the corners adjacent to it; thus, the bottom side of the triangle represents constant X values with variations in Y and Z. The constant value for X is given at the adjacent apexes as 15%; therefore the line represents 15% of X. Noting the the dotted line AO one can read from $O = 15\%$ of X to $A = 50\%$ of X. Since the difference between A and O is $50 - 15 = 35$ and since there are

7 divisions (35 ÷ 7 = 5) each division must be equal to 5%. Point P must therefore contain 30% of X.

On following through this same reasoning for the other two sides, the right side will be found to represent constant 10% Y and the left side constant 40% Z. This being known, one can proceed to further identify the composition of P. It contains (40 + 10 = 50) 50% of Z and (10 + 10 = 20) 20% of Y and as already determined 30% of X.

In a similar manner any point on the diagram can be identified.

To obtain the value of a point such as P in terms of the compositions ABC, the diagram is read exactly the same as the diagram Fig. 5 neglecting the XYZ values.

This description of the use of the three most common types of triaxial diagrams is necessarily brief but it is complete. These diagrams are exceedingly useful and it is unfortunate that more than three variables on such a diagram cannot be conveniently plotted.

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THE EFFECT OF ADDITIONS OF CaO AND MgO ON ENAMEL GLASSES[1]

By C. W. Parmelee[2] and D. T. H. Shaw[3]

ABSTRACT

An attempt to determine quantitatively the effects of various additions of CaO and MgO to a simple soda-lead-silica glass upon the physical properties of the glass and the working properties of the same when used as an enamel was made in this investigation. The tests on glass consisted of thermal expansion, softening range, compressive strength, modulus of elasticity, solubility in acid and alkali, and index of refraction.

Introduction

An ordinary enamel formula contains as many as ten or more constituents. Such oxides as SiO_2, SnO_2, B_2O_3, Al_2O_3, Sb_2O_3, K_2O, Na_2O, CaO, MgO, ZnO, BaO, PbO, etc., are not infrequently found together in one enamel. While some of the constituents are essential for refractoriness, others for opacity, and still others for fluxing action, it is doubtful whether the addition of a multiplicity of oxides should be more advantageous than using just enough constituents to give the desired properties. It is the purpose of this investigation to develop some workable enamels out of a simple soda-lead silicate through the additions of various amounts of lime and magnesia and thereby to determine the effects of each of the oxides upon the properties of the enamels.

But enamels are, after all, glasses. The fundamental properties of an enamel would be expected to be governed by those of the glass. Tests on glass are simple since they do not involve the consideration of any metals, as is the case with ordinary enamel coats. Hence, this investigation includes a determination of the physical properties of simple lime and magnesia-soda-lead glasses, and aims at correlating these if possible, with the working properties of the same glasses when used as enamels.

Field of Investigation

The field to be studied was a simple glass having SiO 58%, PbO 22%, and Na_2O 20%, to which various amounts of lime and magnesia were added. Three series of compositions were made: (1) the lime-soda series, (2) the magnesia-soda series, and (3) the lime-magnesia-soda series. Figure 1 is a triaxial diagram showing the compositions studied, and Table I gives the melted weight percentages as well as the raw batch weights of each glass.

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Glass Division).

[2] Professor of Ceramic Engineering and Head of the Department of Ceramic Engineering, University of Illinois.

[3] This paper was prepared from a thesis submitted by the junior author in partial fulfillment of the requirements for the degree of Master of Science in Ceramic Engineering in the Graduate School of the University of Illinois.

Preparation and Properties of the Enamels

The enamels were prepared by fritting and then grinding to pass a 100-mesh sieve. The test pieces were cast iron, 2 by 4 inches, and on these a fairly refractory commercial ground coat was applied. All the enamels were fired on the same ground coat using the dry process, with the same firing time (five minutes), but at different maturing temperatures.

Preparation of the Glasses

Melting of Glass It was necessary to obtain glasses free from bubbles. At first vacuum fining was used. The pulverized frits were melted in a crucible jacketed by another one wound with platinum wire. The melt was subjected to an absolute pressure of 5 cm. Hg throughout the time of melting. This method gave glasses which were free from bubbles, but was soon abandoned because only a small amount of glass could be made at a time, and each melting took one day.

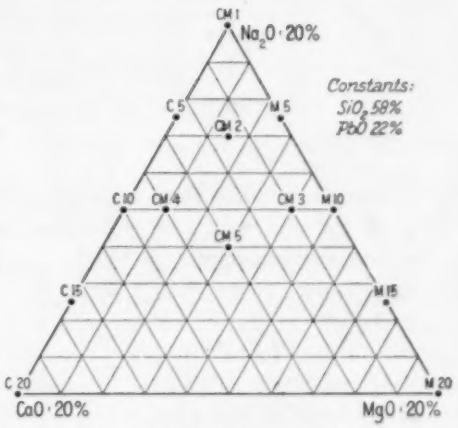

FIG. 1.—Field of investigation.

The method finally adopted for preparing the glasses for the compression, solubility, expansion, and refractivity test pieces was to make the melts in shallow 8-inch square saggers placed inside a surface combustion furnace where the melting took place from the top of the batch. The large ratio of exposed surface to the volume of the melt, together with the very small hydrostatic pressure imposed by the glass itself, greatly facilitated the escaping of bubbles from the melt. As a result, this method of fusion gave glasses which were practically free from bubbles, and at the same time a large volume of glass could be made.

The glasses after being cooled, were broken into pieces which had comparatively regular shapes and which were then ground to suitable sizes for the various tests.

For the elasticity tests, melting in a crucible was the only practical method. The glass after being fined was cast into bars by means of molds made of copper strips. In some cases bubbles were unavoidable. Care was taken to select pieces as free from bubbles as possible.

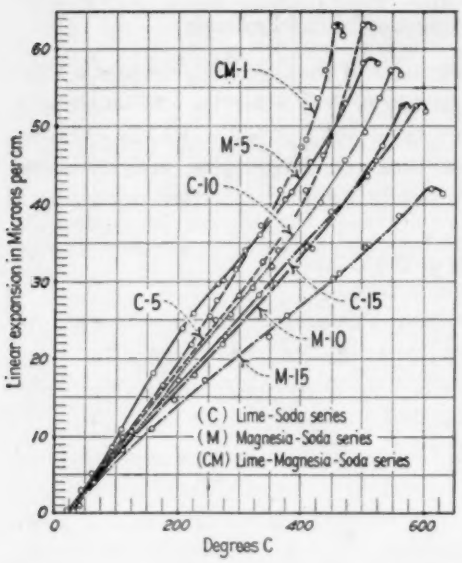

FIG. 2.—Linear expansion vs. temperature.

Dimensioning of Test Pieces All pieces were ground down to the desired shapes by means of a lap wheel. After annealing, the pieces were further ground with 200-mesh Carborundum, until the dimensions, from end to end, did not vary more than 0.01 cm. for compressive strength tests, and 0.02 cm. for elasticity and solubility tests. For expansion tests the pieces were not allowed to vary more than 0.0002 cm. from each other.

Elimination of Strain The annealing was done in an electric furnace, the temperature being kept at about 30° below the softening point of the glass for one hour. A polarizing microscope with a gypsum plate as the accessory was used to detect any strain. Sometimes it was necessary to anneal for a second or even a third time for complete removal of the strain before the tests were made.

Thermal Expansion

The dimensional change of enamel glasses with temperature relative to that of steel or cast iron, largely determines the behavior of the product during cooling after firing, and also is a partial measure of the thermal endurance of the finished ware. This part of the investigation was planned to determine the effects of CaO and MgO upon the expansivities of enamel glasses.

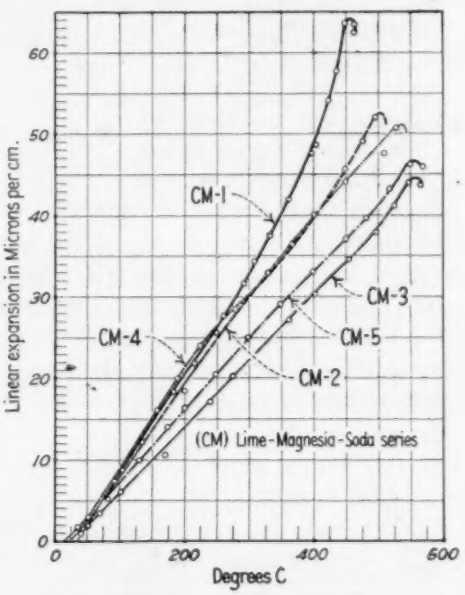

FIG. 3.—Linear expansion vs. temperature.

The Fizeau-Pulfrich interferometer method, the extreme sensitiveness of which enabled the use of very small sizes of samples, was used and thus simplified the problem of uniform heating and temperature control. The equations used were

$$L = \frac{\lambda N}{2}; \qquad C = \frac{N\lambda}{2L\,\Delta t}$$

Where L = change in length
λ = wave-length of helium light (yellow)
N = number of fringes that passed the reference mark
C = mean coefficient of thermal expansion
Δt = temperature range over which measurements were taken

The electric furnace was heated at the rate of 4°C per minute. The maximum temperatures used were slightly above those of the softening points of the glasses. The expansion-temperature curves are shown in Figs. 2 and 3. The experimentally calculated cubical expansion coefficients are shown in Fig. 4, and Fig. 5 shows the relation between the experimental cubical coefficients and those calculated from the factors of Mayer and Havas.[4]

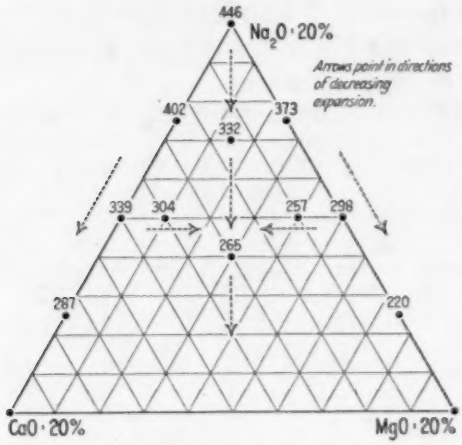

FIG. 4.—Cubical expansion vs. composition.

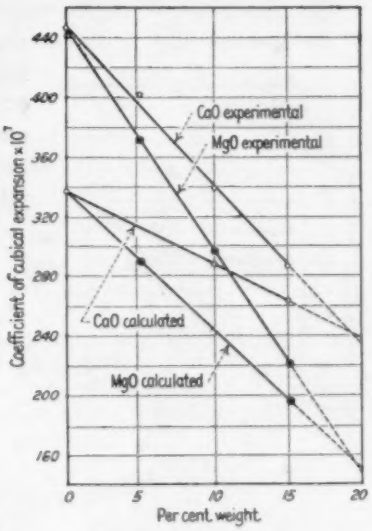

FIG. 5.—Cubical expansion vs. composition.

From these graphs, the results can be summarized:

(1) Additions of CaO and MgO to the glasses decreased the linear expansion.

(2) Magnesia-soda glasses expanded less with heating than the corresponding lime-soda glasses, the lime-magnesia-soda glasses being lower than either one.

[4] *Sprechsaal*, **44**, 188–91, 207–10, 220–22 (1911).

(3) With constant soda content the presence of CaO in a magnesia-soda glass, or the presence of MgO in a lime-soda glass, caused the expansion to be lower than when either oxide was present alone.

(4) With small amounts of CaO and MgO, the experimental coefficients and those calculated from Mayer and Havas' factors differed appreciably. But when the additions amounted to about 15%, the difference became small, and with further additions, there would probably be no difference. This leads one to believe that the Mayer and Havas factors might have been derived from glasses containing fairly high amounts of lime and magnesia.

(5) To prevent crazing or shivering, the expansion coefficients of the enamels must be nearly equal to that of cast iron, which is 310×10^{-7}. This accounted for the smooth finish and freedom from defects of enamels CM-2, M-10, CM-4, and C-10, which had cubical expansion coefficients of 332, 298, 304, and 339, respectively. This also accounted for the nonworkability of enamel CM-5 whose coefficient was 264.

Refractoriness

The necessity for the adjustment of the fusibility of the enamel to that of the ground coat is well known to enamelers. The refractoriness also may have some bearing on the solubility of enamels. Here it was interesting to find out the effects of CaO and MgO upon the refractoriness of the enamels and the softening points of the glasses.

The former was determined by the best working temperature for firing the dry-process enamels when the firing time was kept constant. Also, for convenience of comparison, all pieces

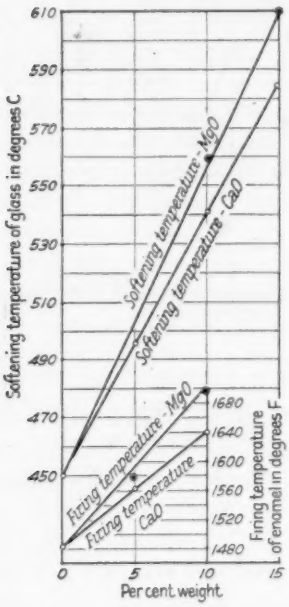

FIG. 6.—Refractoriness vs. composition.

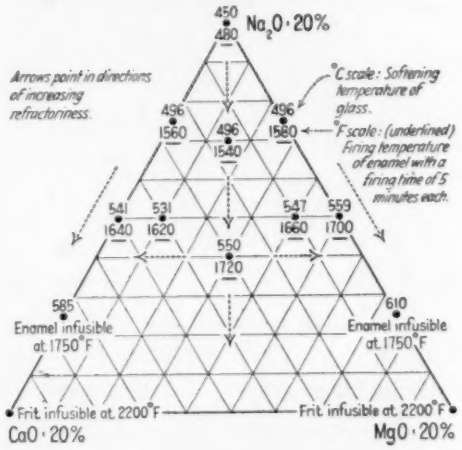

FIG. 7.—Refractoriness vs. composition.

were the same in size and thickness, had the same ground coat and had the same thickness of enamels applied.

The softening points of the glasses were determined from the linear expansion-temperature plots as derived from the interferometer measurements. The softening points were taken as the temperatures at which the expansions suddenly stopped and contraction began. This was shown by the reversal of the direction of travel of the fringes across the field of view.

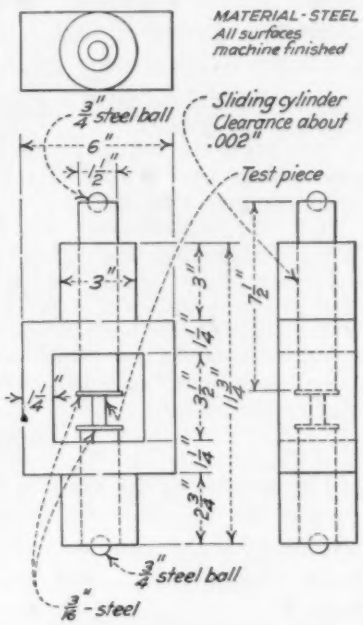

FIG. 8.—Holding device for compression.

The results are shown in Figs. 6 and 7, from which we can say that:

(1) Additions of CaO or MgO at the expense of Na_2O raised the softening points of the glasses and the firing temperatures of the enamels approximately linearly. (2) Lime-soda glasses were less refractory than the corresponding magnesia-soda glasses.

(3) When CaO and MgO were both present in a glass, the softening point of the glass as well as the firing temperature of the enamel was lower than when the glass contained equivalent amounts of either CaO or MgO alone. This depression of the melting point of one component by another is well known in physical chemistry.

(4) The relation between the softening point of a glass and the firing temperature of the enamel was linear. A more fusible glass was accompanied by a lower firing temperature of enamel. Hence, either one would serve as a criterion of the refractoriness of the composition in question.

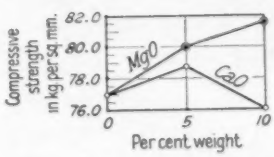

FIG. 9.—Compressive strength vs. composition.

Compressive Strength

The chipping of enamel is usually a result of failure by compression. A knowledge of the crushing strength of glass is useful in the design of the product. Lime is reputed to give weak glasses. It was the purpose of this investigation to determine the truth of this and, in general, how additions of CaO and MgO affect the compressive strength of glasses and enamels.

Glass prisms, about 1 cm. square and 3 cm. high, were used for the compressive strength tests. It was necessary for the shape to be true and the two ends perfectly parallel. After annealing to remove any strain the

samples were crushed in a Riehle 50,000-lb. machine. On account of the extreme brittleness of glass, the eccentricity introduced by the ordinary spherical-seated grips might lower the strength to a fraction of its true value. Hence, a specially designed loading device (Fig. 8) was used to insure axial loading.

The results are given in Fig. 9. The graph suggests that:

(1) CaO did not seem to impart appreciable increase to the compressive strength of glasses.

(2) MgO seemed to give some increase of strength. The magnesia-soda glasses were a little higher in compressive strength than the corresponding lime-soda glasses.

(3) The experimental values, when compared with those calculated from Winkelmann and Schott's factors[5] were about 10% lower. This difference might be due to the fact that while Winkelmann and Schott used pieces in the form of cubes, the shapes used in this experiment were rectangular prisms with a length-to-width ratio of three to one. The latter shape might give lower values for strength than cubes, but possessed the advantage of being the standard form used in similar tests for many other materials.

Modulus of Elasticity

The modulus of elasticity is the ratio of unit stress to unit strain. A glass of low elasticity will therefore be stressed less than one with high elasticity for the same unit strain. Hence a low modulus in glass will favor mechanical endurance and prevent excessive stress in distorted articles.

The method used for determining the modulus of elasticity was based on the principle of the cantilever beam. Glass bars, about 1 cm. square in cross-section, and about 15 cm. long were securely fixed at one end to a heavy iron block. A weight of five hundred grams was applied to the free end by means of a specially made knife-edged stirrup. A deflectometer measuring to one ten-thousandth of an inch was fixed at the free end. The deflection produced upon application of the load was measured and estimated to the nearest hundred-thousandth of an inch.

The differential equation for this case is:

$$EI\frac{d^2y}{dx^2} = -PL$$

which upon integration and equating x to zero to get condition of maximum deflection gives:

$$E = \frac{4PL^3}{bd^3\Delta}$$

Where E = modulus of elasticity
I = moment of inertia
$\frac{dy}{dx}$ = slope of the elastic curve

[5] See Jena Glass, Hovestadt, translated by J. D. and A. Everett, London, 1902.

P = effective load
L = effective length of beam
b = breadth of beam
d = depth of beam
Δ = deflection

The results were plotted and are given in Figs. 10 and 11. It can be concluded that:

(1) The modulus of elasticity increased linearly with increasing amounts of MgO or CaO at the expense of Na_2O.
(2) MgO increased the elasticity more than CaO.

Solubility

By the term "solubility of glasses," ordinarily we mean the degree of attack by acids and alkalis. When one reflects upon the extensive use of glass and enamel ware in households, industries, and laboratories for containing various

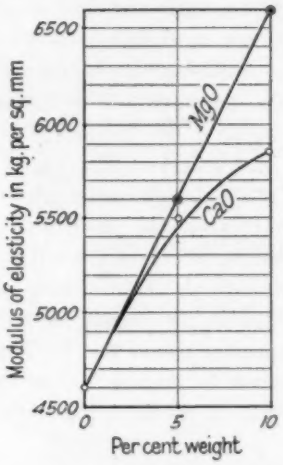

FIG. 10.—Modulus of elasticity vs. composition.

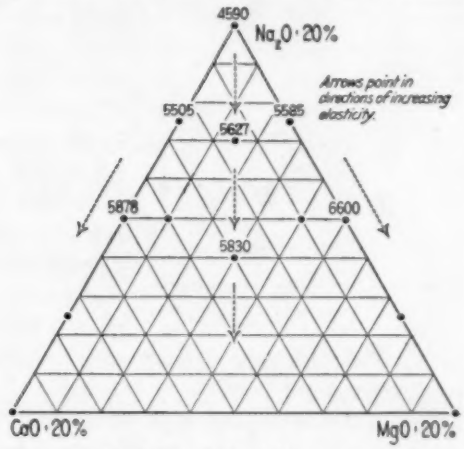

FIG. 11.—Modulus of elasticity vs. composition.

kinds of solutions which are being heated, the importance of solubility is apparent.

The method used was to immerse glass cubes in 10% HCl and in 10% NaOH at 100°C for three hours, and to express solubility in terms of the weight dissolved per unit surface exposed to the attack of the reagents. This method was considered better than using glass powders, and expressing solubility as per cent loss of weight in terms of the original weight for two reasons: First, the velocity of chemical attack may be correctly assumed to be proportional to the surface exposed. Equal weights of different glasses, even of the same sized grains, may not have the same amount of surface. Second, dry glass powder is very hygroscopic. The amount of

moisture adsorbed during cooling and weighing in an ordinary 1-g. sample may introduce considerable error, since the actual amount of glass dissolved is very small.

The results are shown in Fig. 12 from which we can conclude that:

(1) Increasing amounts of CaO or MgO at the expense of Na_2O increased the resistance toward attack by both HCl and NaOH.

(2) Magnesia-soda glasses were slightly more soluble in HCl than the corresponding lime-soda glasses. With regard to decomposition by NaOH, the magnesia-soda glasses were less resistant than the lime-soda glasses.

(3) Under the same conditions, NaOH attacked a given glass more than HCl.

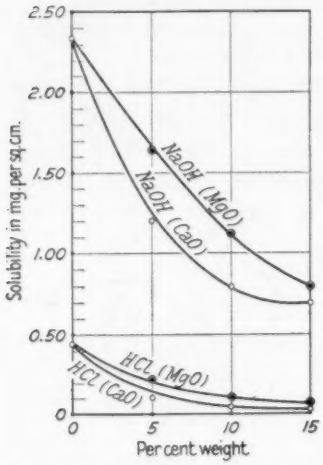

FIG. 12.—Solubility vs. composition.

Index of Refraction

While the importance of the index of refraction is not so apparent in enamels as it is in glasses, nevertheless, no investigation of glass would be complete without its determination, because the brilliancy of a glass is best indicated by its index. Besides, the opacity of the enamel may be a function of the refractivity of the glass.

In this investigation, the relative effects of CaO and MgO upon the refractivity of glasses were determined by means of the well known oil-immersion Becke test.[6] The glasses were powdered to pass a 100-mesh sieve. An ordinary petrographic microscope with a medium-high objective was used.

Results are shown in Figs. 13 and 14. It will be seen that:

(1) Additions of CaO and MgO at the expense of Na_2O increased the index of refraction in a linear manner.

(2) CaO gave a higher refractive index than an equivalent amount of MgO.

(3) The results showed that there was a relation between opacity and refractivity, since increase in the index of glass and increase in opacity of enamel ran parallel both in lime-soda and magnesia-soda glasses and enamels.

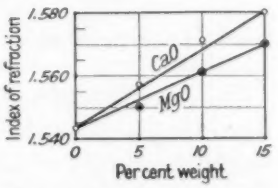

FIG. 13.—Index of refraction vs. composition.

Conclusions

(A) Comparison of the effects of additions of CaO or MgO at the expense of Na_2O.

[6] See Elements of Optical Mineralogy, Part I, by Winchell, John Wiley and Sons, New York.

(1) The opacity of an enamel was increased when either was present in excess of 10%.

(2) Both decreased the thermal expansion in a linear fashion.

(3) Both increased the softening points of the glasses and the firing temperatures of the enamels. Enamels containing 15% of CaO or MgO were infusible in ordinary enameling furnaces, and glasses containing 20% of CaO or MgO were infusible in ordinary fritting furnaces.

(4) MgO increased the compressive strength of glass.

(5) Both MgO and CaO increased the modulus of elasticity of glass, the effect of MgO being the greater.

(6) Both markedly decreased the solubility in alkalis and, to a lesser extent, in acids.

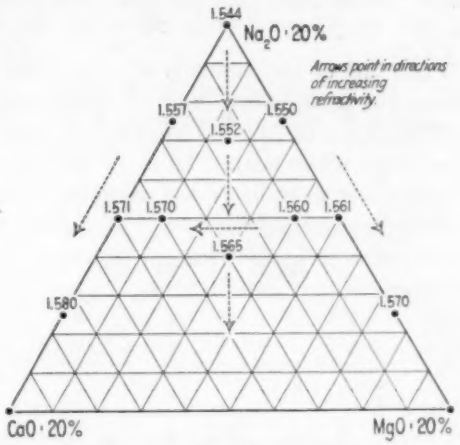

FIG. 14.—Index of refraction vs. composition.

(7) Both increased the index of refraction in a linear fashion.

(B) Comparison of the effects of CaO with those of MgO.

(1) CaO gave slightly higher opacity than MgO.

(2) CaO gave a higher thermal expansion than MgO.

TABLE I

COMPOSITIONS

	Melted weight (%)					Raw batch (%)				
Glass No.	SiO_2	PbO	Na_2O	CaO	MgO	Flint	Red lead	Soda ash	Whiting	Heavy MgO
CM1 Base-glass	58	22	20			50.45	30.00	19.55		
Lime-Soda-Series										
C5	58	22	15	5		50.35	19.54	22.42	7.72	
C10	58	22	10	10		50.20	19.52	14.81	15.47	
C15	58	22	5	15		49.60	19.30	7.31	23.79	
C20	58	22		20		49.90	19.40		30.70	
Magnesia-Soda-Series										
M5	58	22	15		5	52.20	20.26	23.04		4.50
M10	58	22	10		10	53.90	20.93	15.90		9.27
M15	58	22	5		15	56.38	21.92	7.10		14.60
M20	58	22			20	57.65	22.41			19.94
Lime-Magnesia-Soda-Series										
CM2	58	22	14	3	3	51.41	19.98	21.20	4.75	2.66
CM3	58	22	10	2	8	53.02	20.65	15.75	3.27	7.31
CM4	58	22	10	8	2	50.70	19.78	15.25	12.52	1.75
CM5	58	22	8	6	6	52.23	20.30	12.42	9.65	5.40

(3) MgO imparted greater refractoriness to enamel glasses.
(4) MgO gave higher compressive strength than CaO.
(5) MgO gave higher elasticity than CaO.
(6) MgO caused glasses and enamels to become more soluble in acids and alkalis than an equivalent amount of CaO.
(7) MgO gave lower refractive index than CaO.

(C) All of the enamels studied were acid resisting. The glass which gave the best enamel had the following composition: SiO_2, 58%; PbO, 22%; CaO or MgO, 5 to 10%; Na_2O, remainder. In no case could a perfectly white enamel be made without adding so much calcium or magsium oxide as to make the resulting composition too refractory for the ordinary enameling furnace. Therefore, where whiteness of the enamel is not important and chemical resistance is of first consideration, the above formula is very satisfactory.

CERAMIC ABSTRACTS

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Abrasives

Artificial abrasives. ANON. *Pit and Quarry*, **19** [13], 64 (1930).—Artificial abrasives fall into three main groups: (1) metallic abrasives such as crushed steel, steel shot, and steel wool; (2) silicon carbide abrasives such as Carborundum, Crystolon, and Carbolon; and (3) aluminium oxide abrasives such as Alundum, Aloxite, Exolon, and Lionite. The metallic abrasives are used chiefly in loose form as cutting agents in sawing or drilling rock and other hard materials. An important use of the silicon carbide and the aluminium oxide abrasives is in the manufacture of bonded abrasive wheels. The abrasive grains graded into uniform sizes are bonded together into wheels of varying degrees of coarseness and hardness. A fusible clay is used as the bonding material in vitrified grinding wheels. Sodium silicate, shellac, and Bakelite are also employed as bonding materials. E.P.R.

Abrasives and grinders. D. G. MILANI. *Corriere ceram.*, **10** [12], 451–57(1929).—The value of an abrasive depends on the quantity of crystallized Al_2O_3 which it contains. The best quality of emery contains 55 to 60% Al_2O_3 and is found on theisl and of Naxos, Greece; in Smyrna, Turkey. Corundum contains a higher per cent of aluminium oxide and less iron oxide than emery. Indian corundum contains 75% Al_2O_3, Brazilian 76%, and Georgia corundum 77%. Abrasives prepared in an electric furnace reach a content of 99.17% Al_2O_3. Silicon carbide has few impurities and a specific gravity of 3.22. An analysis shows 67.50% silicon and 28.57% carbon. M.V.K.

Abrasives are used to prepare petrographic specimens. HERBERT R. SIMONDS. *Abrasive Ind.*, **11** [4], 28 (1930).—Preparing thin sections of fire brick is extremely delicate and many hours of handwork go into each section. The method starts with a quarter-inch section cut from the brick which is to be examined. An important consideration is not to disturb the grain or to introduce any foreign substance. The grinding becomes more delicate as the section grows thinner. The $^1/_4$-in. sections are first ground down by hand against relatively coarse flat grinding wheels. First one side and then the opposite side is ground until the specimen is brought to a little over $^1/_8$ in. in thickness, with both sides smooth and flat. When they have reached the thickness of $^1/_8$ in. they are mounted in wax and the abrasive operation is transferred to a revolving steel disk coated with powdered abrasive. Against this disk the specimens are carefully ground down to a thickness of about $^1/_{64}$ in. At this point, the ground surface is mounted on the glass slide, and the holder which covers the opposite side of the disk is gently removed by heating. The newly exposed surface is then further ground until the desired thinness of specimen has been secured. E.P.R.

Grinding golf club shafts and heads. ANON. *Abrasive Ind.*, **11** [5], 36 (1930).—The adaptability and versatility of the centerless grinder for finishing a large variety of parts is constantly being increased by many new developments. One of the most recent innovations in the field of centerless grinding is the development of a fixture and method for grinding tapered wooden golf club shafts. E.P.R.

Spark test determines metal characteristics. ANON. *Abrasive Ind.*, **11** [5], 29 (1930).—The study of sparks generated when a revolving grinding wheel makes contact with a metal sample has two aspects. One is a broad investigation of cause and effect involving theory and research, while the other is a practical application. This is to check by spark individual pieces from shipments of steel as a part of final inspection, and to sort out mixed lots of steel. Another practical use of the spark method is on samples submitted for selection of wheels to grind a product. Samples frequently are submitted without the composition being specified. The spark test will classify the material and through previous experience will guide the operator in his first choice of the kind of grinding wheel to try. An accompanying chart describes the characteristics. E.P.R.

Mechanical lapping gives impetus to production accuracy. SYDNEY PLAYER. *Abrasive Ind.*, **11** [5], 23–26 (1930).—Recent developments in lapping cylindrical work and flat surfaces opens a wide range of possibilities to the service of abrasive machines and products. The article gives the results made possible by mechanical lapping, and is abstracted from a paper presented at a recent meeting of the A.S.M.E. P. is a pioneer in the precision lapping field and is now associated with the Norton Co. E.P.R.

Grinding hot-rolled bars. REVERE CHAPELL. *Abrasive Ind.*, **11** [5], 22 (1930).—Drill rod and similar steel bars are ground accurately with such ease on centerless machines that this method has become standard for bars in that class. Attempts to grind hot-rolled bars have also met with encouraging results, but they are not as satisfactory as is the case of drill rod. E.P.R.

Grinding carboloy. ANON. *Abrasive Ind.*, **11** [5], 22 (1930).—The regrinding of carboloy grooving tools is the greatest factor affecting their life and successful performance. To obtain the maximum life from a carboloy grooving tool it is absolutely necessary that they be lapped on the sides and ends. A straight edge set at 90° to the cutting face and a steady rest set to the proper front degree clearance must be used. It is only necessary to lap off from 0.0025 to 0.0004 in. to put the tool back in good cutting condition. Care should be taken to keep the tool from slipping away from the straight edge set at 90° to the cutting face. E.P.R.

High-speed wheels in production grinding. E. D. BISHOP. *Abrasive Ind.*, **11** [5], 20–22 (1930).—In the article which gives the results of practical experience, it is pointed out that high-speed grinding wheels are coming into favor steadily. B. is an abrasive engineer associated with the Detroit-Star Grinding Wheel Co. The fact that present-day equipment is not always adequate for operating the new wheels is stressed and it is predicted that eventually high-speed wheels will be used extensively on production grinding operations. E.P.R.

Effecting savings by carefully ground tools. ANON. *Abrasive Ind.*, **11** [5], 37 (1930).—Important savings in time and costs have been effected in the use of gages, tools, and other equipment by the Ford Motor Co., as the result of the successful application of hard chrome plating to these gages and machine parts. Experiments were conducted to find the kind of wheels to use in grinding the steel, and the proper method of heat treatment. Plate gages now are giving 218 hours in certain grinding operations where formerly four was the limit. Costs have been reduced more than one-half. E.P.R.

Face mill grinding. ANON. *Abrasive Ind.*, **11** [5], 45–46 (1930).—For sharpening

quickly and accurately face mills 8 in. in diameter and up to and including 18 in., a new face-mill grinding attachment has been developed by the Cincinnati Milling Machine Co., Cincinnati. E.P.R.

PATENTS

Grinding machine. ALVIN R. BERCK. U. S. 1,755,862, April 22, 1930. In a device of the class described, an arbor, a pair of spaced flat circular disks carried by the arbor, a plurality of circumferentially spaced members extending edgewise between the disks and movable radially thereof, an abrasive element encircling the outer side edges of the members, and means for adjusting the members relatively to the arbor and the disks to vary the diameter of the abrasive element correspondingly for grinding engine cylinders, etc., of different sizes.

Lapping and grinding device. JOHN W. OMEY. U. S. 1,755,965, April 22, 1930. A grinding device comprising a working head having central and radial bores, a sleeve connected to the working head, an adjustment mechanism in the central bore of the working head, an extension shaft connected to the adjustment mechanism, the shaft extending through and beyond the sleeve and provided with means for operating the adjustment mechanism, support members mounted in the radial bores of the working head, the support members having channels therein parallel to the axis of the working head, abrading members mounted in the channels, abutments in the channels at the ends of the abrading members, and means carried by the abutments whereby the support members are retained in adjusted position.

Lapping tool. RAY D. STREBY. U. S. 1,756,014, April 29, 1930. A lapping tool comprising, in combination, a supporting frame, a plurality of hangers pivotally supported on the frame, a shaft rotatably mounted in each hanger, a lapping roll at the end of each shaft, the lapping rolls being conically disposed and arranged in a circular series whereby they are adapted to lap the inner surface of articles having a conical bore, spring devices engaging the hangers to force the lapping rolls against the work, and means for rotating the shafts.

Mounting for abrasive wheels, etc. GEORGE W. PERKS. U. S. 1,756,259, April 29, 1930. A mounting for abrasive wheels having surfaces with minute elevations and depressions, comprising plates at the sides of the wheel, wire mesh between the plates and the wheels, and means to force the mesh against the sides of the wheel sufficiently to cause the wire mesh to embed within the depressions on the wheel.

Wheel-dressing device for grinding machines. FRANKLIN JUDGE AND ALDEN M. DRAKE. U. S. 1,756,646, April 29, 1930. In a grinding machine, a work holder, a wheel, a wheel dressing tool positioned, when operative, in proximity to the holder, a hand lever effective in one position to cause relative travel of the tool past the wheel to dress the wheel, and effective in another position to cause relative travel of greater extent to permit replacement of the work, and to simultaneously displace the tool transversely to the wheel axis from operative position.

Grinding apparatus. MARTIN TUTTLE. U. S. 1,756,710, April 29, 1930. In a grinding apparatus including a motor having a grinding wheel mounted on its armature shaft, an attachment comprising a bracket rigidly fixed to the motor and extending laterally therefrom, a movable bracket extending across the fixed bracket and adjustable longitudinally thereof, means for maintaining the movable bracket in a position at right angles to the fixed bracket, a support for a work object carried by the upper end of the movable bracket, the line of adjustment of the movable bracket relative to the fixed bracket being parallel with a line through the axis of the grinding wheel and through the point of contact of a work object on the support with the periphery of the wheel, whereby a constant bevel may be maintained on the edge of the work object being ground, the movable bracket also being adjustable transversely of the movable bracket

and the work support being correspondingly pivotally adjustable on the movable bracket, whereby a work object on the support may be caused to engage a different point on the periphery of the wheel without changing its angular relation to a line drawn through the point of contact and through the axis of the wheel, together with graduations to guide in making corresponding adjustments of the movable bracket transversely and of the work support.

Grinding wheel. THOMAS F. EMMINGER. U. S. 1,756,734, April 29, 1930. A grinding wheel having a plurality of openings for receiving abrading elements and provided with slots in the periphery adjacent the openings and an element supporting shaft extending through the openings and provided with an angular end seated in the slots.

Machine for grinding or cutting toothed gear wheels, etc. ARTHUR HITCHCOCK ORCUTT AND JOHN WILDSMITH SNARRY. U. S. 1,756,876, April 29, 1930. In machines for grinding toothed gear wheels or similar objects, the combination comprising a rotary grinding wheel, a reciprocatory slide on which the wheel is mounted, a work carrying slide movable in a direction at right angles to the direction of motion of the slide carrying the grinding wheel, means for imparting feed movements to the work carrying slide, a trimming tool, a slide carrying the trimming tool, means for imparting feed movements of the slide carrying the trimming tool, and means for correlating the two feed movements.

Grinding machine. WILLIAM J. BAUMBERGER. U. S. 1,756,908, April 29, 1930. In a grinding machine, a work spindle, a grinder spindle, an oscillatory support for one of the spindles, mechanism for oscillating the support, and a driving mechanism common to the work spindle and oscillating mechanism, the driving mechanism including a change-speed mechanism adjustable to simultaneously varying the speed of rotation of the work spindle and the speed of oscillation of the support in relatively small increments over a relatively wide range of speeds.

Portable grinding tool. ERR S. MCGONEGAL. U. S. 1,756,949, May 6, 1930. A portable grinding tool comprising a motor including a motor casing, a supporting bracket fixed to the motor casing and constituting a fixed support for supporting the motor in a predetermined operative position, a grinding spindle housing mounted on the motor casing in external parallel relation thereto and adjustable circumferentially about the motor casing, a grinding spindle journaled in the grinding spindle housing and adjustable therewith to different operative positions in external radial relation to the motor casing, and a driving connection between the motor and the grinding spindle effective in all adjustments of the latter.

Grinding machine. JOHN BATH. U. S. 1,757,161, May 6, 1930. In a grinding machine, a base, a wheel table slidable thereon, a lead screw for the wheel table, a nut for the lead screw, a bearing bracket for the nut, means to detachably secure the bracket on the wheel table, and means for adjusting the nut relative to the bracket and to the lead screw thereby to take up wear.

Grinding machine. OWEN DOUTT. U. S. 1,757,175, May 6, 1930. In a grinding machine for curved bars, the combination with a rotary grinding element, of a rotary feed wheel, the periphery of which has the same curvature as the bars to be ground, means on the periphery of the feed wheel for engaging the ends of the bars, spring means for engaging the bars to urge them toward the feed wheel, and spring means on the periphery of the wheel against which the bars are yieldingly held.

Grinding machine. OWEN DOUTT. U. S. 1,757,559, May 6, 1930. A work feeder for a grinding or buffing machine comprising a wheel adapted to support the work on its peripheral surface, and means carried by the wheel for resiliently retaining the work on the surface of the wheel.

Centerless grinding machinery. GEORGE W. BINNS AND WALTER D. ARCHEA. U. S. 1,757,612, May 6, 1930. A centerless grinder including a grinding wheel having a centrally recessed peripheral face with projecting side flanges and a regulating wheel having a plain portion opposing the centrally recessed face of the grinding wheel and having a beveled portion adjacent one of the flanges of the grinding wheel as an entrant guide for work introduced between the wheels and means for axially shifting a work piece transversely of the face of the wheels.

Gashing and sharpening hobs. ALLAN H. CANDEE, ERNEST C. HEAD, AND LOUIS D. NADEL. U. S. 1,758,103, May 13, 1930. (1) In apparatus of the character described, a tool support, a tool mounted thereon, a rotatable work support, a slidable table upon which one of the supports is mounted, means for imparting a cutting movement to the tool, means for moving the table to cause the tool to move longitudinally of the work, a differential, means actuated in timed relation with the table movement for rotating one element of the differential at a uniform velocity, means actuated in timed relation with the table movement for rotating another element of the differential at a varying velocity, and means operatively connecting the differential with the work support. (2) In a machine for fluting or sharpening hobs, a frame, a rotary work support, a table slidably mounted on the frame for movement in a direction longitudinal of the work, means for actuating one of the parts, a cam, gearing for driving the cam from the actuated part, a differential gearing for driving one element of the differential from the cam to impart thereto a movement at a varying velocity, gearing operatively connecting the other two elements of the differential with the two first mentioned parts, respectively, a tool support, a tool mounted thereon, and means for actuating the tool, the table being adapted to carry one of the supports.

Grinding machine. WILLIAM H. CHAPMAN. U. S. 1,758,649, May 13, 1930. In a centerless grinding machine, in combination, a grinding wheel rotatable at relatively high speed, a regulating wheel rotatable at relatively low speed, the grinding wheel moving downwardly and the regulating wheel moving upwardly with respect to an interposed work piece, and a work guide having work engaging portions located in an arc of a radius equal to that of a finished and accurately sized work piece, the work guide being located wholly at the side of the axis of the work piece opposite the regulating wheel whereby the work is held from lateral displacement by a plurality of contacts with the guide without loss of rolling contact with the regulating wheel.

Adjustable flyer-grinding device. ALBERT M. GUILLET. U. S. 1,758,791, May 13, 1930. In a grinding machine, a base portion, a rotary grinding implement mounted on the base portion, a bell crank lever pivotally mounted on the base portion, a perforated member supported by the bell crank lever, a pin on the upper end of the bell crank lever located in alignment with the perforation in the perforated member, the perforation and pin being adapted to receive a tubular member, and means for swinging the bell crank lever to bring the tubular member in contact with the grinding means.

Abrasive article. FRANCIS G. OKIE. U. S. 1,759,168, May 20, 1930. Process of manufacturing a stable waterproof abrasive article in the nature of sandpaper, etc., which includes incorporating a grit of comminuted abrasive particles in a waterproof adhesive material, applying such incorporated grit and adhesive material to and permitting it to penetrate the sheet for maintaining the bonding effect throughout the effective abrading life of the article when used in a water-abrading operation, and compensating for such penetration of the sheet by simultaneously applying another coat to the back of the article as an auxiliary waterproofing and bonding agent.

Drill grinder. THADDEUS A. JACKSON. U. S. 1,759,196, May 20, 1930. In a drill grinder having a drill holder, and means for feeding the same, a stationary head stock, drive shafts longitudinally slidable therein, a revoluble support, a grinder mounted

to oscillate thereon toward and away from the drill center, means for rotating the support to carry the grinder bodily around the center of the drill, and means for reciprocating the drive shafts and support and grinder relative to the stationary head stock in a longitudinal plane toward and away from the drill for the purpose set forth.

Abrasive wheels. G. C. MARKS. Brit. 325,888, April 24, 1930. An abrasive wheel is built up of segments which may be united to form an annulus by cementitious material, held by side clamping plates drawn together by screws. The segments have reduced portions in which are formed spaced recesses adapted to be engaged by spaced lugs.

Tail center for grinding machines, etc. J. BATH. Brit. 326,016, April 24, 1930. The tail center of a grinding machine, etc., is moved in one direction by a spring and in the other by hydraulic fluid which is admitted through a hand-controlled valve to a cylinder. The tail center is cut away to allow clearance for the grinding wheel and is mounted in a sleeve slidable in the tail stock.

Grinding plane irons, etc. F. WOBST. Brit. 326,370, April 30, 1930. A device for holding plane irons and other tools during grinding consists of a frame having pivoted thereon a work rest adjustable by means of a screw pivoted thereto.

Feeding work pieces to machines. H. RENOLD, LTD., R. O. HERFORD, AND A. RENSHAW. Brit. 326,604, May 7, 1930. In means for supply blanks to grinding, turning, and punching machines, the blanks are supplied to an inclined trough and thence to a tubular shoot, the shoot being slightly spaced from the end of the trough to allow blanks which are not in line to drop into a hopper. The blanks proceed along the shoot by gravity and may be assisted by power-driven means to be fed through a machine.

Grinding cylinders. A. E. WHITE. Brit. 326,623, May 7, 1930. A cylinder hone comprises grinding stone carriers mounted in a rotating body so that they can rock but not move circumferentially thereto. The carriers can be moved radially outward against the action of springs by cone-ended pins engaging cone recesses and operated by a double cone member which is moved axially by a screwed sleeve rotated by a rod. The pins are further apart than the recesses so that the stones can rock and thus automatically adjust themselves to the work.

Grinding lathe tools, etc. H. A. DUDGEON. Brit. 326,671, May 7, 1930. A machine for grinding and sharpening lathe tools, drills, cutters, etc., consists of a horizontal spindle running in plain, taper, or ball or roller bearings which may be adjustably mounted in head, and carrying at its ends grinding wheels. The head is secured to or integral with a bowl having an extension rotatable in a column and secured in adjusted position by screws which enter a groove in the bowl.

Grinding machines. H. A. DUDGEON. Brit. 326,676, May 7, 1930. In a machine for grinding lathe tools, etc., a belt pulley is loosely mounted on a spindle so that it may be rapidly engaged or disengaged, the spindle being carried by a rotatable head. The pulley runs on two ball bearings and is formed with an extension bored conical to receive a conical portion on a spring pressed collar slidably keyed on the spindle and actuated by the eccentric portion of a pin rotatable by a handle. Grooves are formed in the clutch faces to remove oil, etc., from them.

Art and Archeology

Art Division Symposium. ANON. *Jour. Amer. Ceram. Soc.*, **13** [5, Part II], 7–66 (1930).—A collection of papers by members of the Art Division presented at the Toronto Meeting is printed. This includes: "The Rôle of Art in Industrial Ceramics" by E. de

F. Curtis; "Design Problems of the Tableware Industry" by Arthur E. Baggs and Marion L. Fosdick (see *Ceram. Abs.*, **9** [3], 150 (1930)); "The Place of Design as a Merchandising Factor in the Glass Industry" by Harold S. Nash; "Art Pottery" by Myrtle Meritt French; "Discussion Concerning the Needs of the Tile Manufacturers for School Trained Designers" by Paul E. Cox; "Training Required for the Work of an Architectural Colorist" by Mary L. Hull (see *Ceram. Abs.*, **9** [3], 151 (1930)); "Study of Cadmium-Selenium Red" by Henry Marley (see *ibid.*); "A Study of Turquoise Blue Glaze" by G. M. Petersen; a "Report on Terra Cotta." A bibliography of Art Division articles published in the publications of the SOCIETY concludes the collection. E.J.V.

Modern Louisiana pottery. RALPH A. GRAVES. *Nat. Geog. Mag.*, **57** [4], 463 (1930).—For more than forty years Newcomb College has fostered the decorative arts, but going beyond the usual sphere of art-school work, it has specialized in ceramics and Newcomb pottery has become world-famous. It is made at the school by professional potters (Newcomb graduates), while the designs, no two of which are supposed to be alike, are originated by the students. Illustrated. E.J.V.

Seen in the galleries. MARTY MANN. *Studio*, **96** [396], 10–12 (1930).—The Rookwood Pottery in Cincinnati, founded by Mrs. Storer, is based on the idea of individualism and has enjoyed steady expansion. One discovery, the "butter-fat" surface, is a refinement of glaze texture like those of the Chinese potters. A limited edition of Persephone modeled by Wayland Gregory has been produced by Cowan Potteries with the idea of making fine sculpture available to modest incomes. In Wanamaker's Old Silver Room is a Tigerware jug dated 1567, a rarity of great beauty of Rhenish stoneware, a grayish fawn with fine granulated markings of reddish brown. It is mounted in silver gilt. Illustrated. E.B.H.

Changes in decoration of pottery manufacture. J. WALLEY. *Pottery Gaz.*, **55** [635], 823–24 (1930).—W. reviews the changes that have taken place since his early association with the industry in 1862. His views on the various processes in use are given. E.J.V.

Quality in pottery. JOSEPH BURTON. *Jour. Roy. Soc. Arts*, **78** [4027], 279–98 (1930); for abstract see *Ceram. Abs.*, **9** [4], 292 (1930). G.R.S.

History of the mirror. ANON. *Sprechsaal*, **63** [10], 177 (1930).—The origin of the mirror is not known but the first mirrors were made of highly polished metals. During the time of the Roman Empire thin metal plates (gold, silver, copper, iron, tin) were used for mirrors. It is also possible that panes of glass were coated with thin layers of melted metal. Mirrors coated with lead have been found. Plinius describes the use of "vitrum obsidium" which is a black volcanic stone resembling feldspar. Large wall mirrors were made from it, the shape of the mirrors being round, with a convex or concave surface. Special mention is made of the mirrors of the Egyptians who were masters of ornamentation. Their mirrors were very richly decorated and had handles of different shapes, sometimes in the form of flowers, gods, and goddesses. M.V.K.

Plating glass and clay. EUGEN WERNER. *Sprechsaal*, **63** [13], 223–24 (1930).—The main difficulty in electroplating nonconductive materials as glass, porcelain, and organic bodies is to make them conductive; as soon as the surface of such a material is covered with a conductive coat the most difficult work is done. The oldest method was to use a pure graphite with a metal. To plate a gypsum piece it must be immersed in liquid wax. After hardening it is covered by a paste of bronze powder with alcohol and traces of mercury chloride and dried. To render clay or porcelain conductive, cover with a graphite composition and heat to 200°C or 400°C. The addition of volatile oils to the graphite batch increases the adhering capacity of graphite. The starting point for pieces which are covered with a graphite or metallic powder is always an acid

copper bath consisting of 11 g. water, 220 g. copper sulphate free from zinc, arsenic, and iron, and 30 g. of sulphuric acid free from arsenic. Correctly covered porcelain objects are indestructible. M.V.K.

Fantasies and cameos in glass. ANON. *Christian Sci. Mon.*, **22** [104], 11 (1930).—René Lalique has applied all the wonderful genius for design he possessed as a jeweler to the task of translating it fully into glass. The variety of Lalique's productions is one of the best features of his genius. There are bowls and screens for lights and ash trays, boxes, vases, finger bowls, fruit dishes and motorcar mascots. Some of the designs which Lalique employs are of the very simplest character. Others are so intricate that they take weeks to perfect. Human figures are used in many designs, modeled or engraved with rhythm and grace. In other pieces birds, beasts, and fishes are reproduced with great fidelity. His methods of manufacture and production must necessarily remain a secret. Opal-tinted glass is one of Lalique's greatest achievements and a favorite medium. He employs many other shades, to all of which the frosted finish of the design gives a pastel effect. There are browns, blues, greens, and grays. At times, as in the case of wall plaques and some of the mascots, a colored electric globe brings the design into strong relief while leaving the background transparent. His versatility is demonstrated also by his architectural work. Glass is a friable material, and Lalique's work will inevitably become rare and valuable in years to come. Illustrated. E.J.V.

Laboratory for working glass in the State Academy for Applied Arts, Dresden. ANON. *Sprechsaal*, **63** [13], 227–29 (1930).—The course is as follows: (1) drawing of models from the museum of Dresden; (2) drawing from life; (3) special shaping and technical studies on the basis of (*a*) glass blowing according to the Thuringer manner as school practice for the shaping of glasses, (*b*) form shaping in glass grinding, (*c*) glass engraving and diamond cutting, (*d*) glass etching, (*e*) sand radiate blowing. Interesting and original effects are obtained by the students and many objects are of very high quality. Illustrated. M.V.K.

Table glassware. ANON. *Christian Sci. Mon.*, **22** [103], 6 (1930).—Glassware of American design fits in with the present trend of simplicity in table setting. Table glassware is on the whole simple in line and decoration, suggestive of peasant art, but etched and gold-banded pieces may be chosen for best occasions. The "modern art" vogue is now expressed in ebony glassware, with blocked but tasteful lines. E.J.V.

Modern stained glass designer. ANON. *Pencil Points*, **11** [5], 365–66 (1930).—Modern stained glass windows are described and illustrated. E.B.H.

Opal-flashed glasses. G. KÖRRN. *Ceram. Ind.*, **14** [5], 526–29 (1930).—For abstract see *Ceram. Abs.*, **8** [11], 789 (1929). F.P.H.

Famous French cathedral glass on exhibit at Toledo Museum. ANON. *Amer. Glass Rev.*, **49** [29], 34 (1930).—The famous St. Bonitus' Window, which was once in Chartres Cathedral, is now on exhibit at Toledo Museum. The glass was molded during the period of Chartres and critics place the value above the rubies it is said to resemble. It is composed of tiny pieces of pure colored crystals, principally red and blue. The design is unpainted except for the features of St. Bonitus. E.P.R.

Fabrication of fine porcelain in Italy. C. F. BONINI. *Corriere ceram.*, **10** [12], 457–71 (1929); **11** [1], 3–19; [2], 71–81; [3], 103–13 (1930).—The history of the manufacture of fine porcelain and its development in Venice, Romagna, Ferrara, Toscann, Lombardy, Piedmont, and Liguria is given. M.V.K.

Royal Society of Arts competition of industrial designs. ANON. *Chem. News*, **140** [3644], 99–100 (1930).—The Seventh Annual Open Competition of Industrial Designs was held at the Imperial Institute, South Kensington, London, in June, 1930. In the pottery section prizes were offered for models executed in fired pottery of a morning

tea set; an ornamental group of figures, animals, or birds for a narrow shelf or mantelpiece; and a commemorative plaque suitable as an award in the pottery and glass section of the Royal Society of Arts competition. In the glass section prizes were offered for designs for a perfumery bottle for high-class trade and a grapefruit glass. G.R.S.

Exposition of Swedish arts and crafts. ANON. *Amer. Traveler's Gaz.*, **80** [2], 20–21 (1930).—For the summer of 1930 leading representatives of the Swedish industrial art movement have gathered under royal patronage to prepare an exposition in Stockholm of modern Swedish arts and crafts and home industries. In the exhibits of 1930 there may be studied the styles of modern Swedish architecture and the practical and artistic uses of various mediums, wood, brick, granite, glass, and faience. Interior decoration offers a particularly rich field since it is in the development of artistic products in engraved crystal glass, pewter, silver, ceramics, and decorative textiles that Swedish crafts and industries have won international fame. Illustrated. E.J.V.

Lessons in design from ancient Mound Builders of Ohio. FELIX PAYANT. *Design*, **31** [2], 22–25 (1930).—The Mound Builders' pottery exemplified feeling for simple dignity of form and clay technique in decoration. Illustrated. E.B.H.

Cahokia mounds. WARREN K. MOOREHEAD AND MORRIS M. LEIGHTON. Univ. of Ill., *Bull.*, **21** [6], 97 pp. (1923).—Types of Indian pottery are described and illustrated. The mounds are located in southern Ill. A.J.M.

Italian majolica. FRANK DAVIS. *Illus. London News*, **176**, 140 (1930).—The exhibition of the art of Italy held in London contained a very choice collection of ceramics. The first dated piece of majolica is 1475, and the finest period 1520 to 1560. Although Gubbio, Deruta, Padua, Castel Durante, and Caffagiolo produced identifiable ware, there are many which await attribution. Illustrated. H.H.S.

Discoveries in Albania. FEDERICO HALBHERR. *Illus. London News*, **176**, 25 (1930).—Excavations at Bouthrintos by the Italian mission under Ugolini have been remarkably rich in results. The terra cotta found includes statues, dedicatory inscriptions, and over 300 ex-votos. H.H.S.

Design of primitive African pottery and textiles. CHARLES F. RAMUS. *Design*, **32** [1], 2–7 (1930).—Contrasted with Greek pottery, African ware lacks refinement of shape and texture but has a rugged beauty in the contour and designs incised by scratching with a blunt instrument, or molded on the surfaces The designs are symbolic. Illustrated. E.B.H.

Tombs at Corinth. I. JOSEPHINE PLATNER. *Art and Archeology*, **29** [5], 195–202 (1930).—In the North Cemetery of Corinth in excavated graves were found large water jars having small geometric bowls as stoppers, assigned to the period succeeding the Mycenaean. In a large crater with linear motifs is seen the survival of geometric design. At first only the lips of vases were decorated but later narrow parallel stripes on the body were adopted. This type is called Proto-Corinthian. The prosperity of Corinth is attributed to the earth and metal arts there. Excellent clay beds account for the ceramic industry. Illustrated. E.B.H.

First excavation at Petra. AGNES ETHEL CONWAY. *Illus. London News*, **176**, 160–61 (1930).—The Henry Mond expedition, under the direction of George Horsfield, to the "rose-red city," has produced results of considerable interest. Among the pottery finds down to the Bronze Age were some peculiar to Petra, the saucers being of almost incredible thinness. The designs were not under classical influence; the Nabataeans had their own culture. Illustrated. H.H.S.

"Rhodian" (Turkish) and Persian pottery. FRANK DAVIS. *Illus. London News*, **176**, 180 (1930).—One result of the war has been to make the pottery of the provinces of the former Turkish Empire more accessible to study. The pottery known as Rhodian

is now proved to be Turkish, and the ware found in Sicily and called Siculo-Arabic is today definitely catalogued as Syrian. Persian ware and the influence of Persia on other ware are discussed. H.H.S.

Chinese porcelain of 17th and 18th Centuries. FRANK DAVIS. *Illus. London News*, **176**, 30 (1930).—An illustrated account is given of the later ceramic ware of China, which began with the fall of the Ming dynasty in 1644. Kang-hsi, famille noire, famille rose, and famille verte are described. H.H.S.

BOOK

National Museums and Galleries. Final Report, Part II of Royal Commission. H. M. Stationery Office, London, 1930. Price 2s. This volume comprises the conclusions and recommendations relating to individual institutions. H.H.S.

PATENTS

Design for bottle. PAUL B. THOMPSON. U. S. 81,079, April 29, 1930; WALTER T. WALKER. U. S. 81,169, May 13, 1930; CARL A. PETERSEN. U. S. 81,202, May 20, 1930.

Design for jar. WALTER D. TEAGUE. U. S. 81,167, May 13, 1930; SAMUEL ROSS. U. S. 81,207, May 20, 1930.

Design for border strip for service ware. HENRY A. PICKARD. U. S. 81,071, April 29, 1930.

Design for tumbler. JOHN E. MARSDEN. U. S. 81,061, April 29, 1930.

Design for goblet. OLIVER S. ATTERHOLT. U. S. 81,121 and 81,122, May 13, 1930.

Design for plate, etc. GEORGE WESP. U. S. 81,170 and 81,171, May 13, 1930.

Design for lavatory leg. HARRY R. TROUT. U. S. 81,034 and 81,035, April 22, 1930.

Design for light-diffusing globe. WILLIAM F. REED. U. S. 81,147, May 13, 1930.

Design for statue. GEORGE S. BRUSH. U. S. 81,176, May 20, 1930.

Cement, Lime, and Plaster

Use of aquagel in cement, mortar, and concrete. ANON. *Pit and Quarry*, **19** [13], 72–75 (1930).—Aquagel as supplied to the building trade for incorporation into cement, mortar, or concrete is a grayish white powder. It is a silicate material similar in chemical composition to Portland cement and forms a jelly-like mass when mixed with 25 times its weight of water. This property and its affinity for cement are probably the reasons for its value in mortar and concrete. When a paste or slurry is made from cement and water in the proportions usually required there is a segregation of the coarse particles of the ground cement clinker from the finer particles. This segregation in the cement paste is a cause of crazing, dusting, and hair-cracking of cement work. One of the purposes of aquagel is to preserve the uniformity of the composition of the cement paste, thus improving strength and eliminating crazing, cracking, and dusting. E.P.R.

Calculation of the compounds in Portland cement. R. H. BOGUE. *Ind. Eng. Chem. Anal. Ed.*, **1** [4], 192–97 (1929).—The bases for a calculation of the compounds present in Portland cement from chemical analyses are given. Arithmetical and diagrammatical methods are given for such a calculation. The compounds considered are $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$, $3CaO \cdot Al_2O_3$, $2CaO \cdot SiO_2$, $3CaO \cdot SiO_2$ uncombined MgO, uncombined CaO, and $CaSO_4$. Other components than those included in these compounds are not at present considered as their forms of combination are not known. R.G.M.

Cement moduli. HANS KÜHL. *Tonind.-Ztg.*, **54** [23], 389–92 (1930).—For lack of definite knowledge concerning the chemical structure of Portland cements, a makeshift, the cement modulus, was adopted to establish at least a numerical relationship. The introduction of the hydraulic modulus by Michaelis was a great achievement as it furnished a definite basis for the manufacture of cement which had been more or less conjectural before that time. The hydraulic modulus is an incomplete expression for the lime content of a cement. The most recent investigations show that the cement containing the greatest quantity of lime, which can be chemically combined with silicic acid, alumina, and iron oxide, is the best cement. The theoretical lime content can be expressed by the formula: $CaO = 2.8SiO_2 + 1.65Al_2O_3 + 0.7Fe_2O_3$ If one supposes that this is the theoretically highest possible lime content for a given quantity of silicic acid, alumina, and iron oxide, then the degree of lime saturation of a cement is obtained by comparing its actual lime content with the theoretical "highest possible" lime content of the cement. Accordingly, for a given cement the degree of saturation by lime S can be expressed: $S = \frac{CaO}{2.8SiO_2 + 1.65Al_2O_3 + 0.7Fe_2O_3}$. The significance of this new consideration is clear if one realizes how meaningless is the standard specification that the hydraulic modulus of a Portland cement must be greater than 1.7. A cement richer in silicic acid than a cement with a hydraulic modulus 1.7 is of inferior quality. In cements poor in silicic acid, or cements with a high content of sesquioxides, especially when the sesquioxides consist mainly of iron oxides, the hydraulic modulus must be under 2.1 when rich in lime. Tables are given which show that three cements, in spite of an equal hydraulic modulus, show a very different degree of saturation by lime. K. points out that in standard specifications the classification according to the hydraulic modulus should be discarded and the classification according to the degree of saturation by lime adopted instead. The degree of saturation by lime in a Portland cement of at least 0.75 or 0.80 should be required. M.V.K.

Durability of Portland cement. THADDEUS MERRIMAN. *Eng. News-Rec.*, **104**, 62 (1930).—A test is given for distinguishing between cements and for determining their relative qualities of permanence. The solubility of lime in sugar solution parallels the disintegration of the cement in sodium sulphate solutions. As the reaction is modified by the effect of the dissolved lime, the sugar solution is first treated with a definite amount of lime. Titration with acid using methyl orange as an indicator shows a larger solution value than titration using phenolphthalein; the difference between the two values is a measure of the silica iron and alumina in the cement. This difference closely checks the disintegration behavior, and M. offers it as a test of the durability of the cement. The durability is also closely paralleled by the alumina content of the cement, satisfactory durability being shown when the alumina content was below 5.8%. W.L.

Cement dermatitis, cause, and proper treatment. ANON. *Pit and Quarry*, **20** [1], 61 (1930).—Workers engaged in handling Portland cement, both in cement mills and on construction and other work in which cement is used, sometimes suffer from skin burns and eruptions known as cement dermatitis. This condition is caused by the irritating effect of the lime which the cement contains, by the clogging of the pores of the skin by hardened particles of cement, and by the chafing and cutting action of the hard grains against the skin. The best method of preventing cement dermatitis is frequent bathing. It is also advisable to cover the hands and arms with a coating of a suitable ointment to replace the oil in the skin and keep it from cracking. An ointment composed of 3 parts of vaseline to one part of lanoline is suggested. E.P.R.

Effect of tannic acid on strength of Portland cement. F. FEW. *Chem. Eng. Mining Rev.* [Melbourne], **21**, 441-43 (1929); reviewed in *Pit and Quarry*, **19** [5], 102 (1930).—

Tannic acid was selected as the impurity in loam that causes harmful effects in the hardening of concrete. E.P.R.

Cement specifications. ANON. *Commercial Stand. Monthly*, **6** [10], 320 (1930).—New tentative specifications for high early-strength Portland cement have recently been issued by the A.S.T.M. The report of the committee transmitting the specification also embodied a number of proposed changes in the present standard specifications for Portland cement. The changes are minimum tensile strength at 7 days from 225 to 275 lbs./sq. in. and the minimum tensile strength at 28 days from 325 to 350 lbs./sq. in. It is believed that these increased requirements are justified by the generally higher strength of American Portland cements. E.J.V.

International standard specifications for Portland cement. Part I. C. R. PLATZMANN. *Rock Prod.*, **31** [2], 97–100 (1928).—A review is given of present standards in vogue in 25 different countries. P. shows the need of international cement specifications and the probable difficulties in formulating them. Tables showing the standard tests in the 25 countries are given. For Part II see *Ceram. Abs.*, 9 [6], 410 (1930). W.W.M.

Influence of the fineness of Portland cement on its properties. P. FILOSSOFOV. *Tonind.-Ztg.*, **53** [72], 1302–1304 (1929).—A succession of tests made with cements of different fineness for determining the influence of the fineness on the properties of Portland cements gave the following results: (1) An extreme fineness can reduce the tensile strength of a pure cement. (2) The coarse-grained fraction shows a slight activity at the beginning of hardening but after a longer time the activity increases considerably and approaches that of the finest fraction with regard to tensile strength. (3) The most favorable structure for cement grains in regard to tensile strength is obtained when 70% is fine. (4) The solidity of mortar 1:3, as well as the tensile strength and resistance to pressure, increases in accordance with the increase of the fineness of the cement, at least up to half a year of hardening time. M.V.K.

Chemistry of the setting of Portland cement. C. J. VAN NIEUWENBURG. *Gewapend Beton*, **18**, 1–6 (1929); reviewed in *Pit and Quarry*, **19** [13], 87 (1930).—The present sum of our knowledge of the setting of Portland cement and the views most commonly held today are reviewed. The little that is definitely known is that the aluminates are the first and the silicates the last to react; gels are formed either directly or via crystalline products; $Ca(OH)_2$ is probably formed in crystalline form as a by-product. The varying views on the constitution of Portland cement clinker are summarized. E.P.R.

Multistage process for firing Portland cement clinker. R. D. PIKE. *Ind. Eng. Chem.*, **22** [2], 148–52 (1930).—Some large scale experiments in multistage firing Portland cement clinker as conducted by P. are described and the following proposed multistage combinations have been analyzed quantitatively: (1) one calciner in series with one rotary, with rotary gas to the calciner; (2) two calciners in parallel, each in series with one rotary, with rotary gas to the calciners; (3) two calciners in parallel, each in series with one rotary, but waste-heat gases to boiler and a potash recovery plant are included. The third arrangement is shown to be most efficient. The possibility of profitable collection of by-product potash by means of this arrangement is discussed in detail. R.G.M.

Combination of lime with ingredients of argillaceous rock in progressive heating of raw cement mixture. HANS LORENZ AND HANS KÜHL. *Zement*, 604-11 (1929); *Pit and Quarry*, **19** [4], 45–48; **20** [2], 87–88 (1930).—Chemical methods are employed in this investigation to arrive at a complete explanation of the chemical constitution of Portland cement. These methods were selected in preference to the mineralogical method, as the latter has failed to accomplish the desired result. It is pointed out

that the results gained from these investigations have not agreed with the experiences of practical cement chemistry. K. also points out that Portland cement does not consist of tricalcium silicate, dicalcium silicate, and tricalcium aluminate as the main ingredients according to American investigators. The work done by Jänecke on the ternary system, lime-silica-alumina, is also reviewed. J. believes that the presence of jäneckite in Portland cement is substantiated and that this compound plays an important rôle in the structural constitution of Portland cement clinker. L. and K. also call attention to the investigations carried out by Walter Dyckerhoff which have afforded some new and very valuable bases for solving the clinker problem. K. points out that when Dyckerhoff assumes alite to be a dicalcium silicate which has been enriched with lime, the assumption is faulty from the standpoint of the practical cement chemist. New compounds of calcium silicates and calcium aluminates are formed during the heating of the raw cement mixture at very much lower temperatures than are required for the formation of these substances from their pure components. Monath has shown (see *Ceram. Abs.*, **7** [10], 664 (1928)) that new calcium silicates and calcium aluminates are formed at a temperature of 730°C, and that these new compounds exist in appreciable amounts in the clinker at temperatures varying between 800°C and 850°C. L., under the direction of Kühl, was assigned to the task of measuring the free lime in the clinker at different clinkering temperatures to obtain some information on the progress of combination of the lime with the ingredients of the argillaceous rock, as this process actually takes place in heating the raw cement mixture in the cement kiln as it is used in the manufacture of Portland cement on a large scale. The method employed in this investigation together with the results and conclusions are described in detail. E.P.R.

Testing and analyzing cements. PAUL ERCULISSE. *Chim. & Ind.*, Special No., pp. 475–87 (Feb., 1929); reviewed in *Pit and Quarry*, **18** [12], 112 (1930).—E. considers that the evolution of methods for the testing and analysis of cements should be along the following lines: (1) Express the results of chemical analysis by a formula indicating the stoichiometrical relationships. (2) In regard to mechanical tests, use sand of definite size of grains, and make a more fluid mortar containing a little less sand than is used at present and exactly the amount of water theoretically required for setting, the mortar being prepared on a shaking table under specified conditions instead of being mixed by hand. (3) Study the reactivity by LeChatelier's method. E.P.R.

Disintegration of blast-furnace slags. FRITZ HARTMANN AND ALMUTH LANGE. *Stahl Eisen*, **50** [16], 517–18 (1930).—For determining the disintegration of lime the ultra-violet light of a quartz lamp was used in which the presence of the decomposition compound of γ-$2CaO \cdot SiO_2$ was recognized by a yellow glow. The opinion is held that the disintegration of lime is caused by the transformation of β-dicalcium silicates into γ-form with a 10% increase in volume. Four groups of melts could be distinguished: (1) melts without ingredients showing yellow glow, but brittle; (2) solid durable melts not showing the yellow glow; (3) melts with an average content of decomposition material showing the yellow glow, but which were solid; (4) melts which broke completely on cooling and showed a great quantity of yellow decomposition powder with the yellow glow. In another series of experiments the influence of heat treatment in relation to the chemical composition was tested. A greater content of manganese makes slags with a small content of lime brittle so that they break without decomposition of the lime. Raising the alumina content raises the limits of decomposition to a higher lime content; alumina has a favorable effect on the structure of blast-furnace slags. Similar results were obtained with slag rich in magnesia which proved to be especially solid and tough. If the content of FeO is more than 10%, decomposition occurs without showing the yellow glow. Attempts were made to determine

whether a delayed decomposition can be artificially introduced or prevented. A series of samples were weathered in air, water, oxygen, and carbonic acid, but no further decomposition was observed. Attempts were made to accelerate the transformation by introducing the γ-substance into slag suspected of decomposition, but were without results, even when carbonic acid snow was used as cooling agent. Changes in the structure of γ-dicalcium silicates are brought about by heating to redness without a change of the Röntgen picture or the optical properties. Between 375° and 400° the glowing decomposition powder gives a white instead of a yellow glow under the quartz lamp, and between 400° and 1200° a light blue glow. The yellow glow cannot be obtained again by cooling or by introducing the γ-substance. It appears therefore that the yellow glow is not a property of pure γ-$2CaO{\cdot}SiO_2$ but is caused by the presence of impurities acquired while in the grate. Tests confirmed this, since a synthetically prepared $2CaO{\cdot}SiO_2$ did not glow. M.V.K.

Chemical behavior of "Si-stoff," trass, and kieselguhr in lime and cement mortars. P. MECKE. *Tonind.-Ztg.*, **54** [26], 444–46 (1930).—Calcium-sulpho-aluminates, lime silicates, and calcium aluminates are formed from "Si-stoff" and lime. M.V.K.

Effect of free lime in clinker upon its strength-producing properties. HAROLD H. STEINOUR AND HUBERT WOODS. *Rock Prod.*, **33** [9], 70–71 (1930).—Four cement mixes were made up and clinkered to give practically no free lime. The same mixes were also clinkered to give 1 to 2% free lime. Three 7- and 28-day compression tests were made on 1:3 standard sand mortars of all the cements. All cements passed the steam test, but those containing appreciable amounts of free lime were considerably weaker than those containing negligible amounts. Much of this effect is attributed to the decreased tricalcium silicate content. W.W.M.

Breaking down of tricalcium silicate by heat. S. L. MEYERS. *Rock Prod.*, **33** [8], 78–79 (1930).—As a result of tests, M. concludes that in powdered cements tricalcium silicate reverts to dicalcium silicate under the influence of heat, with a concomitant liberation of free lime. None of the other major cement constituents exhibit this property. Clinkers or unground cement materials do not revert under the influence of heat. Aged cements are more susceptible to heat reversion than fresh cements. W.W.M.

Expansion of hydraulic binding agents. LAFUMA. *Rev. mat. constr. trav. pub.*, **243**, 441 (1929) and **244**, 4 (1930); *Rock Prod.*, **33** [7], 83 (1930).—L. discusses the theory of expansion of hydraulic binding agents and concludes that the swelling of the lime results in spontaneous powdering due to increase of the absolute volume of the solid phases during the reaction. The same phenomena is produced when a solid salt reacts without previous solution with a saline solution to give a composition of little solubility. Such a reaction, if it takes place in the body of a mortar, results in forces of disintegration. From the special viewpoint of the theory of hydraulic binding agents, the chemical reactions which put solid salts into action and which give rise to the hydrated little soluble salts, can be divided into two classes: (1) those reactions which occur with previous solution of the solid salts, those which cause the set and the hardening, or those which are favorable to the strength of the mortar; (2) reactions which occur without previous solution of the solid salts, those which cause the chemical disintegration with swelling or expansion of the mortars, or those which are unfavorable to their condition. For improving the condition of mortar, the reaction of the first class should be favored, and that of the second class should be suppressed. W.W.M.

New method of dehydration. D. BALAREV. *Kolloid.-Z.*, **1**, 63–70 (1929); *Sprechsaal*, **63** [13], 233 (1930).—B. endeavors to explain the contradictions in the results of different investigators concerning the dehydration of gypsum. Dehydration of the semihydrate follows neither pure hydrates (monovariant) nor pure zeolithic (bivariant),

but a combination of both. From the properties of these semihydrated dehydrations all the contradictions between the results concerning the dehydration of gypsum or semihydrate can be explained. M.V.K.

Setting and hardening of cement. C. H. DESCH. *Cement and Cement Mfg.*, **3**, 73 (1930).—When water is added to a cement the cement particles become coated with a gelatinous layer in which small crystals subsequently appear. The hardness which results may be partly due to the interlacing of the crystals, but probably much more to the drying of the colloid mass. The products formed in the hydration of cement must vary in composition according to the proportions of the reacting substances. Finer grinding of the cement makes it possible for the reaction to proceed more rapidly and more completely. W.L.

Use of calcium chloride or sodium chloride as a protection for mortar or concrete against frost. W. N. THOMAS. Dept. Sci. Ind. Research [London], Building Research, *Special Rept.*, No. 14; reviewed in *Engineering*, **129**, 237 (1930); see also *Ceram. Abs.*, **9** [5], 335 (1930). W.L.

Anhydrite cement. P. P. BUDNIKOFF. Reviewed in *Pit and Quarry*, **18** [12], 111 (1930); for abstract see *Ceram. Abs.*, **9** [3], 155 (1930). E.P.R.

Colloidal silica and lime. P. JOLIBOIS AND L. CHASSEVENT. *Pit and Quarry*, **18** [12], 111 (1930); see *Ceram. Abs.*, **9** [3], 154 (1930). E.P.R.

Effect of fineness and composition on quantity of water in cement. HANS KÜHL. *Tonind.-Ztg.*, **53** [85], 1509–10; [86], 1527–29 (1929); *Concrete*, **36** [2], 111–16 (1930); for abstract see *Ceram. Abs.*, **9** [3], 154 (1930). H.W.A.

Influence of fluxing materials on grinding. ANON. *Zement*, **19** [5], 96 (1930); *Rock Prod.*, **33** [9], 80 (1930).—The fluidity of cement slurry depends to a considerable degree upon the extent to which the raw materials can be disintegrated by washing. An investigation was made to determine the influence of electrolytes on the disintegration rate of a mixture of marl and chalk in the wash mill. One drum received water without any electrolyte; the other drum received a 0.04 *N* Na_2CO_3 and 0.1% molasses solution (based on the weight of the slurry). A screen analysis and an analysis by elutriation was then made in the Schoene apparatus. Electrolytes had an accelerating influence on the reduction in size of the raw material. The introduction of the electrolytes decreases the consumption of fuel, increases the output of the kiln, crushers, and pumps, and calls for smaller bins and tanks. W.W.M.

Necessity of uniform feeding of dry pulverized materials. H. A. SCHAFFER. *Concrete*, **36** [2], 107–108 (1930).—Improved methods of feeding pulverized coal should be applied to dry-ground raw materials in the manufacture of cement. Some of the evils of uneven feeding are discussed. H.W.A.

Testing cement. G. HAEGERMANN. *Cement and Cement Mfg.*, **3**, 69 (1930).—The essential properties of cement are soundness, setting time, and strength; fineness, unit volume, and specific gravity are of less importance. The accelerated test for soundness is universally used, but experiments have proved that cement not complying with the accelerated test may be sound in practice. The accelerated tests do not indicate expansion due to the presence of gypsum and should be supplemented by observation of pats placed in cold water. Initial set indicates the beginning of the setting reaction but the final set merely represents an arbitrary degree of hardening of no special importance and should be replaced by a strength specification at an early age. Tensile and compressive tests indicate different qualities of the cement. Since tensile stresses are seldom met with in concrete structures, the true strength of mortars is best judged by its compressive strength. W.L.

Essential properties of cement not yet guaranteed by the manufacturer. OTTO GRAF. *Cement and Cement Mfg.*, **3**, 30 (1930).—The testing of materials for standard

tests should be carried out so as to allow the results of the tests to be applied to actual practice. This requirement is not entirely met with cement. The compressive and tensile strengths are carried out on mortar specimens which are not a true indication of results to be obtained with concrete. They give no indication of volume changes, resistance to corroding agents, workability, or permeability. W.L.

Physical properties of hydrated cements. R. E. STRADLING. *Cement and Cement Mfg.*, **3**, 19 (1930).—Volume changes occurring in hydrated cement are discussed. Curves are given which show the relative expansion which takes place when previously dried specimens of various building materials are immersed in water. With neat cement and cement mortars the expansion increases when increasing quantities of cement are used. With neat cement specimens of varying thickness the rate and extent of expansion when stored in water or contraction when stored in air decreases as the thickness of the specimen increases. These changes in length result in the formation of cracks in the neat cement, but such cracks are less noticeable in mortars and concrete. In the mortar the volume changes result in a concentration of stress around the inert particles, which leads to flow with a consequent release of stress. Failing release by this means, minute cracks are produced in the cement envelope around the inert particles to allow the release of stress. If the stress is sufficiently great major cracking may occur even in the presence of inert aggregates. W.L.

Cement moduli and quality factor. A. NILSSON. *Pit and Quarry*, **19** [9], 83 (1930); for abstract see *Ceram. Abs.*, **9** [4], 255 (1930). E.P.R.

Technologic information about gypsum and lime cements. A. J. HOSKIN. *Pit and Quarry*, **20** [1], 39 (1930).—Treatise on the means of production of plaster of Paris. E.P.R.

Use of gypsum waste products. P. P. BUDNIKOFF AND W. M. LECHOJEV. *Ceramics and Glass*, **5** [11], 432–35 (1929).—The great quantity of waste gypsum from ceramic industries can be utilized in various ways. After being fired the gypsum can be used for plastering or in the preparation of anhydrite cement. When waste gypsum is fired at 500° or 700° no catalyzers are necessary to aid the setting; such a cement has a shrinkage of 1 to 1.5%. The addition of catalyzers as 0.6% $NaHSO_4$ or 0.8% $CuSO_4$ prevents shrinkage and lowers the setting time. M.V.K.

Recent progress and development in the gypsum industry in Canada. R. M. SANTMYERS. *Pit and Quarry*, **20** [1], 65–70 (1930); for abstract see *Ceram. Abs.*, **8** [12], 866 (1930). E.P.R.

Gypsum as source of lime, cement, and other products. O. F. HONUS. *Pit and Quarry*, **19** [11], 89 (1930); for abstract see *Ceram. Abs.*, **9** [3], 157 (1930). E.P.R.

Canada Gypsum and Alabastine, Ltd. ANON. *Pit and Quarry*, **18** [12], 87–94 (1930).—The history of the gypsum industry in the province of Ontario, Canada, dates back to 1822. The plant and its system of operation are described. The production includes calcined gypsum, gypsum blocks, and gypsum boards. E.P.R.

Rotary kiln in cement manufacture. W. GILBERT. *Cement and Cement Mfg.*, **3**, 41 (1930); for abstract see *Ceram. Abs.*, **9** [6], 412 (1930). W.L.

Waste heat in revolving kilns. HANS ENGEL. *Tonind.-Ztg.*, **54** [24], 408–409 (1930).—Meade found that 44% of heat is lost through the chimney, 19% for expelling water from the raw slip, and 10% by radiation. Attempts were made to reduce this waste by making the kiln longer, thus obtaining a greater surface of contact between the raw charge and the hot gases. The use of waste-heat boilers gave good results as about 160,000 cal. were reclaimed. The loss of heat for expelling water from the raw slip is reduced by the use of the filter method where the slip contains only 18 to 20% water on entering the kiln. This procedure works better if the slip is warmed to about 35°. It is the opinion of E. that revolving kilns should not be made longer. M.V.K.

Waste heat from clinker in a revolving kiln and air for combustion. ANON. *Tonind.-Ztg.*, **54** [21], 351–55 (1930).—Diagrams show the waste heat recovered through preheating the air of combustion, in per cents of the total heat expenditure, together with the temperature of the air of combustion which can be obtained. Curves showing the quantity of air for different consumptions of heat and the heat content itself at different temperatures are given for more exact calculations. M.V.K.

Operation of a modern shaft cement kiln. HAEGERMANN. *Tonind.-Ztg.*, **53** [70], 1269–71 (1929).—The operation of a modern shaft kiln for firing cement can be outlined in the following manner: The shaft kiln consists of a sheet metal shell with only one layer of refractory brick; ordinary fireclay brick in the zone of preparatory heating, and highly refractory brick in the vitrifying zone. H. gives a description of many patents for shaft kilns already in use. M.V.K.

Heat balance of lime kilns in theory and practice. FR. LIPINSKI. *Tonind.-Ztg.*, **53** [5], 82 (1929); *Rock Prod.*, **33** [4], 80–84 (1930).—The reaction $CaCO_3 \longrightarrow CaO + CO_2$ is assumed to take place in the lime kiln. L. divides the kiln into three zones: cooling, dissociation, and preheating zones. He assumes certain existing conditions and calculates theoretically the following items: (1) Cooling zone: (*a*) heat given up by burned lime, (*b*) heat furnished by impurities (in lime), (*c*) nonsensible heat of drawn lime, (*d*) radiation losses in cooling zone; (2) Dissociation zone: (*e*) heat of dissociation, (*f*) radiation losses in dissociation zone, (*g*) heat lost by waste gases; (3) Preheating zone: (*h*) radiation losses in preheating zone, (*i*) heat losses by water evaporation, (*k*) heat transferred to impurities (in limestone), (*l*) sensible heat recovered from waste gases for preheating limestone. The effects of impurities in the limestone, moisture, and ash content of the fuel and excess combustion air, upon fuel consumption,

HEAT BALANCE IN LIME KILN

Heat expended (theoretical)			42,520 w.e.
Radiation losses—dissociation zone			5,520 w.e.
			48,040 w.e.
Heat reclaimed from burned lime		10,584 w.e.	
Heat reclaimed from impurities		550 w.e.	
		11,134 w.e.	
Heat Losses			
Retained in lime	425 w.e.		
Cooling zone radiation	153 w.e.	578 w.e.	10,556 w.e.
			37,484 w.e.
(This corresponds to 7.94 kg. coal having a net heat value of 4723 w.e. per kg.)			
Heat in waste gases			40,478 w.e.
Heat Utilized			
Preheating limestone		18,520 w.e.	
Preheating impurities		558 w.e.	
Evaporation of water in stone		3,200 w.e.	
Loss by radiation		1,675 w.e.	23,953 w.e.
Loss by gases escaping from kiln at 414°C			16,525 w.e.

are illustrated. The above fuel consumption corresponds to 15.87 kg. of 7000 w.e. coke per 100 kg. of 97% burned lime. The best large lime plants approach this figure. W.W.M.

Portable concrete testing machine developed. ANON. *Pit and Quarry*, **20** [1], 64 (1930).—Designed for testing concrete used in highway construction, a portable trans-

verse testing machine which weighs only about 40 lbs., but is capable of exerting a force of 4000 lbs., has been developed by Herman C. Berry in the engineering laboratories of the Towne Scientific School, Univ. of Pa. E.P.R.

Recent developments in the Japanese Portland cement industry. MITZUZO FUJII. Paper No. 132 at World Eng. Congress, Tokyo; reviewed in *Pit and Quarry*, **20** [1], 87–88 (1930).—In October, 1928, there were in operation 30 cement mills belonging to 15 companies, members of the Japanese Cement Alliance. The equipment of these plants is summarized. E.P.R.

BOOKS

Cement Handbook. (Zementkalendar 1930). RIEPERT. Zement Verlag, Berlin. 3.60 M. 400 pp. *Z. angew. Chem.*, **43** [5], 119 (1930).—This handbook includes a discussion of the properties not only of all types of cement, but also gypsum and lime. It contains a good-sized section on reinforced concrete. The book has been carefully prepared and gives a comprehensive review of the subject treated. L.T.B.

Some Writers on Lime and Cement: From Cato to Present Time. C. SPACKMAN. Pp. xvii + 287. W. Heffer & Sons, Cambridge, 1929. In his preface, S. describes this volume as an outcome of a long life largely devoted to the chemistry and technology of lime and cement. His researches have given him a fairly intimate knowledge of written work on the subject, his own collection of which is a large one. The writers' names have been arranged in chronological order, and if he possesses their writings or has been able to refer to them, he has also indicated the nature of their contents. It is evident that the book in no way claims to be either a masterly review of the ponderous and rapidly-increasing literature of the topic, or even a terse but comprehensive bibliography of important papers and sources, both of which are badly needed. Nevertheless, it is a little disappointing to find that S. has apparently been largely content with his own library, uniquely comprehensive though that may be. In a work dealing with the literature of cement "From Cato to the Present Time," and dated 1929, one might expect to find some specific reference to the important modern work on the problem of free lime in Portland cement; to Bogue and the splendid work of the U. S. Bureau of Standards recently; to Thorvaldson, Grün, Guttmann, Endell, and to the work of Dykerhoff and others in Germany on the constitution of Portland cement. Yet an incautious reader of this volume might almost gather the impression that little or no progress has been made at all in *post-bellum* times. In the field of building lime, too, the activities of the U. S. National Lime Association's research men and the important recent papers of the Italian school are completely ignored. With these limitations, however, the book can be recommended as an interesting introduction to the earlier literature, and to the beginnings of the scientific study of building limes and calcareous cements. Six and one-half pages of "Definitions" and excellent name and subject indexes are included. (*B.C.A.*)

PATENTS

Artificial marble. JOHANN KNEIFL. U. S. 1,755,399, April 22, 1930. Method of producing artificial marble, consisting in applying a glazing mass consisting of water, potassium carbonate, soda water glass, potassium sulphate, calcium phosphate, and a suitable coloring matter to the surface of a slab of material which can be ground, boiling the slab with the glazing mass in a bath composed of water, calcium carbonate, potassium chloride, magnesium chloride, calcium chloride, nitric acid, acetic acid, sulphuric acid, sodium chloride, magnesium sulphate, and citric acid, at a temperature of 100 to 110°C for about three hours, thereupon placing the slab in a cold bath consisting of water, caustic potash, soda lye, and alum for about three hours, then rinsing with water, drying, grinding, and polishing, as and for the purpose set forth.

Ceramic material and binding agent. VICTOR MORITZ GOLDSCHMIDT AND ROLF KNUDSEN. U. S. 1,756,786, April 29, 1930. Process of producing a building product including artificially produced magnesium orthosilicate comprising the steps of producing a mixture of substances comprising talcum and magnesium oxide and subjecting the mixture to firing so adjusted as to temperature and duration as to result in the entire quantity of talcum and of magnesium oxide in the mixture entering into chemical reaction with one another so as to form the magnesium orthosilicate Mg_2SiO_4.

Method of making cementitious material of cellular texture. GEORGE BOOLE HINTON. U. S. 1,756,789, April 29, 1930. Method of making a cellular fabric which comprises aerating and agitating a mixture of cement pulp and a frothing flotation reagent to form a froth of cement coated bubbles of small and substantially uniform size, incorporating in the froth bubbles of larger size, whereby the larger bubbles will be enveloped by the smaller bubbles.

Production of phosphorus and alumina cement. ROBERT SUCHY. U. S. 1,758,241, May 13, 1930. A process for the simultaneous production of phosphorus and alumina cement from natural calcium phosphates and bauxites, which comprises the steps of melting down under reducing conditions ferruginous bauxites with carbon sufficient to reduce the iron oxide and with calcium oxide in such quantities as to produce a slag containing calcium aluminate and alumina, tapping off separately the regulus of iron and the slag, mixing the slag with calcium phosphates and carbon and melting down the mixture to produce phosphorus, which distills off, and a molten slag which after cooling and grinding constitutes an alumina cement.

Hydraulic cements. G. C. MARKS. Brit. 326,612, May 7, 1930. In a process for the manufacture of cement and sulphuric acid by burning in a rotary furnace a mixture of gypsum, clay, etc., and a reducing agent (*e.g.*, carbon), the mixture is formed into granules, for example balls of 3 to 20 mm. diameter, to prevent the premature action of the oxygen of the air on the reducing agent. It is preferable to use more reducing agent than is theoretically needed.

Plaster compositions. E. JOSZ. Brit. 326,625, May 7, 1930. A plaster composition is made by adding 0.6% by weight of powdered erythro dextrine and between 0.5 and 1.2% of powdered sodium metaborate or sodium pentaborate to dehydrated calcium sulphate. Fillers, etc., such as wood pulp, fibrous materials, cork waste, sand, gravel, cement, coloring matter, etc., may be added.

Enamel

Stainless acid-resisting enamels. H. G. WOLFRAM. *Amer. Enameler*, **2** [12], 6–8 (1930).—Results of tests of Pemco stainless acid-resisting enamel are given. This enamel contains only 44% silica and therefore fires at a temperature no higher than ordinary sheet steel enamel. It was subjected to tests with every commonly known acid, and showed no effect whatever after 72 hours' immersion. Pieces in use under trying conditions for three years have stood up perfectly. Under bending tests this enamel stood up better than ordinary sheet steel enamel and another stainless enamel of high silica content. Under impact test with a one pound hammer Pemco stainless enamel failed at 16 foot-pounds, as against 11.3 foot-pounds for ordinary sheet steel enamel. In the thermal tests this enamel withstood 11 boilings, while 10 boilings is considered satisfactory for good sheet steel enamel. J. N.U., JR.

Development of acid-resisting white sheet steel enamels. A. I. ANDREWS. *Jour. Amer. Ceram. Soc.*, **13** [6], 411–26 (1930); for abstract see *Ceram. Abs.*, **9** [3], 161 (1930).

Cast iron for enameling. A. MÜLLER. *Amer. Enameler*, **3** [1], 3–4; [2], 7–8 (1930); for abstract see *Ceram. Abs.*, **9** [5], 336 (1930). J.N.U., JR.

Black edging. ANON. *Amer. Enameler*, **2** [12], 13 (1930).—Best method of black edging is to fire ground coat, then spray light coat of black edging and fire again. Present day demand for lower costs, however, demands application of black edging right on ground coat and firing it at the same time. Using the latter method requires a black somewhat harder than the ground coat so as not to fire through or change color. Black applied after the ground coat is applied should be of lower firing temperature than the ground coat. Following mill recipes recommended: for edging to be fired with the ground coat, 50 lbs. ground coat frit, 50 lbs. black edge frit, 5 lbs. Vallender clay, 3 lbs. silica, and 2 lbs. black oxide. For black edging applied separately: 100 lbs. black edge frit, 4 lbs. Vallender clay, and 2 lbs. black oxide. Black oxides high in cobalt are found far superior in many ways to those high in manganese and chrome. J.N.U., JR.

Disintegration of iron. WILLIAM C. BOGENSCHUTZ. *Amer. Enameler*, **2** [12]. 22 (1930).—The process of the disintegration of iron under high temperature is described. Analyses of two samples of iron are given, one with a high disintegration point and the other with a lower. Irons which disintegrate at lower temperatures are found to give more trouble in enameling. J.N.U., JR.

Substituting granite for feldspar in ceramic paste. C. KOSTOMAROF AND T. OSSADTCHY. *Ceramics and Glass*, **5** [11], 436 (1929).—Attempts made to substitute granite for feldspar in ceramic pastes proved to be successful. The granite was very finely ground and gave a body much more solid than the feldspar compound. Moreover granite with a large content of mica and iron makes a very good ground coating for black, gray, brown, and yellow enamels. M.V.K.

Enamel defects. EDWARD KETCHEM. *Ceram. Ind.*, **14** [5], 548-52 (1930).—The following defects are discussed: (1) uneven draining, (2) borax spots, (3) blisters, (4) copperheads, (5) hairlines, (6) warping, (7) chipping, and (8) fishscaling. If the proper consistency tests are not applied, the enamel does not drain evenly. It is very difficult to judge the proper amount of enamel to apply to the ware and if consistent results are expected, the human factor should be eliminated. Borax spots are recognized in the finished enamel as a pit, containing at its center a small black dot, and can originate from several different sources. There may be added to the slip an amount of borax in excess of that which the water can dissolve and which crystallizes out of solution in a very short time. Crystallization of the borax can also be caused by allowing the slip to become too cold or by pouring hot borax solution into the slip without the proper amount of stirring. Improper cleaning of the ware or allowing the pickled ware to stand unprotected for several days is a common cause of blistering. Such things as grease, tobacco juice, etc., when splashed on the dried ware before it is fired, cause blisters in a spot formation. Allowing the ware to remain in the pickling acid too long will cause it to absorb a quantity of the hydrogen which is driven out during the subsequent ground coat fire, causing blisters. The use of impure water or chemicals during milling, since they often contain matter capable of producing blisters, is to be guarded against. Oftentimes enamel milled with distilled water will produce results far superior to those obtained with tap water. An excess of setting agents, especially soda ash, has been known to produce blisters due to the liberation of carbon dioxide during firing. When there is exposed a tiny portion of the iron, it oxidizes during the firing and the oxide thus formed is dissolved by the enamel, causing a copperhead. The iron may become oxidized in several ways, or the oxide may be formed on the iron before firing. Copperheads are very difficult or even impossible to cover with the succeeding coats of enamel and are especially prominent with a white cover coat. Thin enamel and overfiring are the two most common causes of copperheads and a check on these operations usually locates the source of the trouble. Warping

is caused by almost the same things which cause hairlines, but the chief cause of warping is probably firing the ware at too high a temperature. This causes buckling of the shape due to expansion and dents due to the marks of the firing points. Chipping usually results from the formation during dipping and draining of beads of enamel at the edges of the ware or other heavy spots in the enamel which break off after the ground coat is fired. Bending the fired enamel also causes it to crack and chip, especially when the enamel is heavy or underfired or when the bending occurs at the edge or corner of the ware. The formation of scale is the result of causes which are obvious and is nearly always easily remedied. Exposed metal during firing is the one main cause of this defect. The fact that the metal is exposed may be due to several things, chief of which is the rubbing-off of the dried enamel while the ware is being placed on the firing racks. The consensus of opinion seems to be that fishscaling is due to a difference in the thermal expansion of the iron used for enameling purposes and the enamel which covers it. Rupture occurs when the enamel has not sufficient strength and elasticity, or when the bond between the enamel and the metal is not strong enough to withstand the strain produced by the difference in expansion of the two materials.
F.P.H.

So-called copperheads. ANON. *Amer. Enameler*, **3** [3], 7 (1930).—"Copperheads" is a term given to a class of enameling flaws which really arise from different causes and therefore have different cures. These causes are (1) overpickling and insufficient neutralization resulting in rusty spots; (2) ground coats fired at too low a temperature; (3) misnamed copperheads which are small crater-like depressions, caused either by poor metal or poor quality ground-coat frits. In all cases a good grade of ground-coat frit is essential to avoid copperheading.
J.N.U., JR.

Removing metal scale. ANON. *Ceram. Ind.*, **14** [5], 552 (1930).—A firm in New England has perfected a method of removal of scale resulting from heat treating and hardening operations on metals, not only from flat surfaces but from such intricate machine parts as gears, shafts, etc., as well as from cutting tools, such as drills, taps, dies, cutters, and reamers. The scale is removed without in any way injuring the surface structure of the steel or metal part. The process is an electrochemical one, the descaling action being brought about by the generation of hydrogen on the work, at the same time protecting the work from hydrogen embrittlement or pitting by coating the cleaned work by depositing a metal on it. This coating remains on the work, if it will not interfere with subsequent operations. It can easily be removed electrolytically if found to be undesirable. This process makes it possible to do away with the handwork formerly necessary, like filing, sandblasting, scraping, and scratch brushing, and thus greatly reduces the labor cost. Further study is being made of the adaptation of this process to the special fields in the metal industry. It is expected that it will have very wide application. The process is said to be so simple that only a small installation is required embracing a motor-generator for the current and tanks in which the treatment is given.
F.P.H.

New cleaner developed. ANON. *Ceram. Ind.*, **14** [5], 562 (1930); for abstract see *Ceram. Abs.*, **9** [4], 265 (1930).
F.P.H.

Continuous equipment for porcelain enameling. S. M. STOLER. *Amer. Enameler*, **2** [12], 14–15 (1930).—As in other industries, continuous equipment in porcelain enameling increases efficiency and decreases cost if not carried too far in cases of small production. Electrically heated furnaces have been found to be more efficient mechanically, thermally, and economically where the electricity rate is not prohibitively high. They also result in less rejects and spoiled pieces and stoppage than fuel-fired furnaces.
J.N.U., JR.

Atmospheric conditions of enameling furnaces. LOUIS NAVIAS. *Amer. Enameler*,

2 [12], 3–5 (1930).—Two types of electric furnaces, the box or intermittent type and the continuous type were equipped with pyrometer holes and samples of the gas were taken at five minute intervals during firing. An Orsat type apparatus was used to determine amounts of CO_2, CO, and O_2; N_2 being determined by difference. In both types of furnaces in the hot zones there was negligible CO and CO_2, while there was approximately 79+% N_2 and 20+% O_2 throughout the firing period. The high O_2 content indicates the thoroughly oxidizing conditions existing in both types of electrically heated furnaces. Testing pressure in the continuous furnace by means of a flame held at the pyrometer holes showed slight outward pressure at the hot zone, enough to keep the vapors from traveling up the incline into the hot zone. J.N.U., Jr.

Continuous electric enameling furnace for resistors. Anon. *Ceram. Ind.*, **14** [5], 560 (1930).—A continuous electric furnace for making vitreous enameled resistors is in service in the plants of several manufacturers. The furnace has a nominal capacity of 2500 finished resistors, each given two coats of enamel per 8 hr. day. This capacity is based on a resistor 1 in. in diameter and 4 in. long, weighing 3 ounces. For smaller resistors, the capacity would be greater. The apparatus requires only one unskilled operator for 1 to 3 furnaces. The power consumption is said to be low and the rejects are said to be reduced to a minimum. The heating cycle includes preheating, firing, and slow cooling the resistors in separate automatically controlled zones. Variable speed drive and full automatic temperature control and recording instruments are included as standard equipment. The furnace is available in several standard sizes. F.P.H.

Accurate control essential in operation of enameling furnace. F. J. Watson. *Fuels and Fur.*, **7** [5], 697–98 (1929).—W. states that the firing temperature, firing time, and speed at which enameled castings approach the maturing temperature of the enamel should be accurately controlled to insure high quality of the vitreous enamel finish on cast iron. W.W.M.

Continuous operating, electrically heated enamel furnace. Anon. *Glashütte*, **60** [3], 40–41 (1930).—Description of a furnace manufactured by the General Electric Co. L.T.B.

Making refrigerators on conveyers. Anon. *Iron Age*, **125** [13], 928–29 (1930).—The assembly plant of the Leonard Refrigerator Co., Grand Rapids, Mich., is described. E.C.C.

Enameling plant records. Harry C. Goudy, Sr. *Amer. Enameler*, **2** [12], 9–12 (1930).—By installing the following system of reports, the superintendent can tell readily what is going on in his plant, what per cent of rejects there are, and what operation is causing these rejects and trouble: (1) a time sheet to be filled out by each operator showing number of pieces, kind of pieces, and time required; (2) sheet made out by inspector showing number and kinds of raw castings after sandblasting, together with number of rejects of each operator, from which weight can be figured; (3) complete record of accepted ware; (4) inspectors' report of complete data of each piece rejected; and (5) report of sheet and cast iron put into work. This system will increase efficiency and decrease waste. J.N.U., Jr.

Lowering costs of enameled ware. H. G. Wolfram. *Amer. Enameler*, **3** [2], 3–4 (1930).—It is not good business practice to lower costs by substituting inferior materials. The cost of frit is always a very small proportion of the total cost of an article. Good frit is essential for a good product, and can be had at perfectly fair prices. Abstract is given of an article in *Emailletechnische Monats-Blatter*, **5**, 103 (1929) describing proper thickness and coating for white enamels. J.N.U., Jr.

Meeting modern enamel requirements. Richard H. Türk. *Amer. Enameler*, **3** [3], 3–4 (1930).—Modern demands require designs which are often difficult to enamel.

These designs are dictated by the consumer and methods must be devised to enamel them satisfactorily. Bright colors also must be produced. A résumé is given of some of the recent achievements in making enamels to meet these requirements. J.N.U., JR.

Does the modern enameler lack initiative? H. R. SPENCER. *Ceram. Ind.*, **14** [5], 554 (1930). F.P.H.

PATENT

Production of molten liquid, coats of enamel, glass, etc., by spraying upon metal, stone, etc. AUGUST PAHL. U. S. 1,756,381, April 29, 1930. Apparatus of the class described, comprising a container, a duct to discharge powder from the container, the duct having an intake end at an elevated point in the container and above the level of the powdered material in the container, a burner tube in which the discharge end of the first named duct is arranged, the burner tube having a gas intake and also having a discharge opening, a duct for compressed air leading to the lower portion of the container and provided with a controlling valve, a duct in the burner tube arranged around and spaced from the discharge portion of the first named duct and a duct for compressed air leading to the inner end of the last named duct, the discharge ends of the last named duct and of the powder discharge duct being opposite the discharge, burner opening, of the burner tube.

Glass

Devitrification of glass: (1) Relative stabilities of different glasses; (2) Time-temperature curves of visible devitrification; (3) Proposed classification of glasses. C. W. PARMELEE AND A. J. MONACK. *Jour. Soc. Glass Tech.*, **13** [52], 322–36 (1929).—Thermal treatments of a number of glasses were obtained by heating glasses in small crucibles until fluid and then slowly cooling for 12 to 15 hours. The glasses were examined microscopically for the presence of crystals. Time-temperature curves were obtained from the results of heating small samples of glass wrapped in platinum foil. After heating for different intervals of time the samples were quenched and examined with the microscope for the presence of crystals. Curves were plotted for the following kinds of glasses, (1) light flint optical, (2) plate, and (3) wire. A proposed devitrification constant, V, can be obtained from the equation $V = \frac{A}{a \times b}$, where A = the area of the rectangle remaining outside of the time-temperature curve, a = the linear measurement in cm. of 100° on the temperature axis, b = similar measurement of 1 hour on the time axis. Glasses were classified as follows: I, those having devitrification constants of 12 or less, II, those having constants greater than 12 and less than 30, and III, those having constants greater than 30. It was found that electric light bulb glass, bottle, two flint optical, crown optical, and zinc oxide glasses were very stable. Fourcault process window glass, wire glass, light barium crown optical, and plate glasses devitrified. Pyrex devitrified almost completely with only one heat treatment. Soda-lime glasses which devitrified below 1000° contained crystals of sodium calcium silicate. Crystals of tridymite and cristobalite were also found. Light flint and light barium crown optical glasses gave crystals of barium disilicate if heated for a rather long time. Tridymite and cristobalite were deposited in Pyrex. G.R.S.

Reduction of glasses in hydrogen. J. T. RANDALL AND R. E. LEEDS. *Jour. Soc. Glass Tech.*, **13** [49], 16–19 (1929).—Glasses in the form of short rods were heated in a clay boat in an atmosphere of dry hydrogen for half an hour. The temperature range was from 500 to 1200°. Pure soda-lime-silica glasses suffered no change but glasses containing arsenious, lead, or ferric oxides were easily reduced. Figures are given showing the effects of heat treatment in hydrogen. The surface of a glass of high arsenic

content was pitted with large craters or burst bubbles. This suggests that the reaction goes on in the interior and the crater-like appearance would be explained by the high vapor pressure of the reduced oxide at 1000°. Tests were made on glasses containing appreciable quantities of ferric oxide. Reduction of ferric oxide in soda-lime-silica glasses will only cause slight changes in color. The experiments described give useful indications as to the impurities in the glass. The method has the advantage of speed, and the changes in color produced by different impurities are so well marked that they can easily be distinguished with a little experience. G.R.S.

Composition of glass used in mechanical processes of manufacture of window glass. II. Determination of chemical resistance. MAURICE SCOHY. *Rev. belge. ind. verrières*, **1**, 26–28 (1930).—The chemical resistance depends upon three factors: (1) compounds formed in the glass, (2) affinity of the oxides for water and their solubility in water, and (3) proportions of the different oxides present in the glass. The affinities of the different oxides for water are arranged in decreasing order as follows: potassium, sodium, barium, strontium, boric, calcium, lead, magnesium, zinc, and silica. The hydrolytic classification of Mylius and Förster is given. The formula of Tscheuschner may be written $Z = K\ (X^2 + 1)$ when the alkaline earth oxides are in unity. Z is the molecular proportion of SiO_2, X is the molecular proportion of alkalis, and K is a constant here taken equal to 3. For glasses of good resistance to chemical action the difference between Z from the above formula and that calculated from the chemical analysis should be less than 1, for glasses of medium resistance it should be between 1 and 3, and for poor glasses it is greater than 3. S. introduces a coefficient of alterability and defines it as the square of the ratio of soda to alkaline earths and designates this ratio as α. He proposes an analytic classification as follows: Class I. Good glasses with α less than 1.5; Class II. Medium glasses, with α between 1.5 and 2; Class III. Poor glasses, with α greater than 2. This classification holds only for glasses with silica percentages between 70 and 72%. For Part I see *Ceram. Abs.*, **9** [6], 419 (1930). A.J.M.

Beryllium glass. II. Potassium-beryllium series. CHI FANG LAI AND ALEXANDER SILVERMAN. *Jour. Amer. Ceram. Soc.*, **13** [6], 393–98 (1930); for abstract see *Ceram. Abs.*, **9** [3], 167 (1930).

Theory of the strength of thermally toughened glass. J. T. LITTLETON, JR., AND F. W. PRESTON. *Jour. Soc. Glass Tech.*, **13** [52], 336–49 (1929); *Chem. News*, **140** [3640], 45 (1930).—Poorly annealed or "toughened" glass has its outer layers in compression and inner in tension. Such glass becomes weak if any part of the interior zone of tension reaches the surface, which is difficult to prevent in any but the simplest shapes of glass articles. In rods, where it is easy to control the distribution of thermal stresses, it was found that some are weaker and others stronger than well-annealed specimens. This has been called "negative hardening" and can be explained in terms of a purely mechanical nature. Equations derived from compression and tension in glass rods show that compression at the surface is equal to the tension at the center, while for a flat sheet of glass compression at the surface is equal to twice the tension at the center. The distribution is taken to be parabolic but observations showed that it was not regularly so. In considering the nature of glass fracture, the fracture will seek for its point of origin some discontinuity of structure that partakes of the nature of a crosswise fissure which is a microscopic or submicroscopic object. Flaws in the interior would need twice as much effort to extend them as would a flaw in the surface. Well-annealed specimens of glass when etched with HF are strengthened by removing a coating of defective strength. Theoretically there is an optimum heat treatment, producing an optimum strain, which is such that when a mechanical pull is applied, the limiting strength of the interior and of the surface is reached simultane-

ously. With more severe heat treatment the glass is weakened and made brittle, while if less severe, the full strength is not developed. Optimum heat treatment introduces at the center a "thermal" stress equal to one-half the ordinary breaking strength of the glass. Glass is usually tested by placing a lath over two supports near its ends and bending it till it breaks. The stress is a compression in the upper fibers and a tension in the lower fibers. The maximum tension occurs in the lower surface and under the point where the load is applied. The break should occur at this point, but very commonly it is rather distant. If theory obtained from a mathematical study were strictly valid, the best possible heat treatment that could be given glass would make it about 3.4 times as strong as well-annealed glass. In practice, glass is commonly broken by getting hit and not by getting bent. Under impact two new sets of stresses appear, (1) vibrating stresses and (2) bearing stresses. Theoretical curve is given for the strength of strained glass as deduced on the basis of the present paper. This is followed by a series of curves obtained from experimental results. G.R.S.

Influence of addition of small quantities of alkaline salts on ease of melting and on working properties of soda-lime-silica glasses prepared from cullet. F. W. HODKIN, W. E. S. TURNER, AND F. WINKS. *Jour. Soc. Glass Tech.*, **13** [49], 47–57 (1929).—Manufacturers realize the benefit resulting from the practice of melting a small quantity of alkaline salts with glass produced otherwise entirely from cullet. Since the effect is not understood a series of studies were carried out with cullet melted with small quantities of sodium carbonate, sodium sulphate, sodium nitrate, or borax. The composition of the cullet prepared in two separate stocks was as follows: SiO_2 75.79, Al_2O_3 0.35, Fe_2O_3 0.06, CaO 9.78, and Na_2O 14.05. The amounts of alkaline salts used were 1%, 2%, and 2.5%. The melting temperature was 1400° and the time of melting was 21 to 22 hrs. A table giving the actual and calculated compositions of the resulting glasses shows that the variation is small. Some salt-cake was lost by volatilization. The order of increasing corrosion on the containing vessel was carbonate, borax nitrate, and sulphate. The most effective salt as far as melting and refining were concerned was sodium carbonate. The salt-cake glass, when no carbon was used, developed boil at the end of the founding period, when working out was begun. Pronounced effects were noted on working properties. Soda ash made softer glass than that produced from cullet alone. Salt-cake additions increased the viscosity of the glass and caused it to set more rapidly. Thick viscous lumps and waves in the glass resulted from alumina dissolved from the pot. These glasses were generally inferior to the soda glasses. Sodium nitrate additions caused extreme mobility, the working properties being less desirable than with soda ash glass. Borax caused a slight skin to appear on the glass, and an increase in the hardness of the glass. The most effective salt in producing easy melting and refining combined with good working properties and the least corrosive was sodium carbonate, with borax coming next in order. All glasses made from cullet with small additions of salts became plain before any glass prepared from a mixture of batch with cullet. These glasses had a longer working range and were slower in setting than those made from batch and cullet. G.R.S.

Note on the viscosity of some glasses of abnormal working properties. S. ENGLISH AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **13** [49], 70–76 (1929).—Glasses of the same composition show different working properties and rates of setting according to the way in which they are prepared, the proportions of cullet used, the amount of moisture in the raw materials, and the coarseness of the limestone used. Such effects are unaccounted for. The effect of continued heating on a glass having the composition SiO_2 72.05, Al_2O_3 6.85, Na_2O 20.62, CaO, and Fe_2O_3 0.20, was reported. After measuring the viscosity between 1390° and 730° the temperature was once more raised to and maintained at 1200° for 20 hrs. and the viscosity again measured. On repeating these

observations no differences in viscosity values were obtained. The variation in viscosity near the annealing temperature of a set of soda-lime glasses was tested. Limestone in different gradings was introduced into the batches. The larger the grain size of the limestone the greater the viscosity and rate of setting of glass. A second series of potash-lead oxide-silica glasses in which the moisture content of the batches varied showed an increase in working viscosity and rate of setting with increasing moisture. Rate of extension and mobility were determined by using rods heated in an electrical tube furnace. Some divergence was noted with the lead oxide glasses but the greatest viscosity as measured by this method was associated with the glass having the lowest working viscosity as measured by the process of practical glass manipulation.

G.R.S.

Effect on properties of soda-lime-silica glass of continued remelting in platinum. V. DIMBLEBY, H. W. HOWES, W. E. S. TURNER, AND F. WINKS. *Jour. Soc. Glass Tech.*, **13** [52], 304–21 (1929).—The authors were concerned with answers to two questions, (1) the changes in chemical composition and (2) in physical properties as the result of the repeated melting at 1400° of a soda-lime-silica glass. Because of the limited quantity of glass which would be obtained, the range of physical tests to be applied was limited to the annealing temperature by two methods, the optical and the thermal expansion, the density (by two methods) and the rate of thermal expansion over the temperature range from the ordinary temperature to the softening point. The glass composition chosen for the experiments was, 73% SiO_2, 9% CaO, and 17% Na_2O. Three series of melts were carried out, the last being the most important. The glasses were melted nine times for 20 hrs. each and drawn into rods after each remelting. Results showed (1) the only change in composition was a slight tendency for the alkali content to fall. (2) This loss of alkali became practically negligible when the glass was heated for 180 hrs. at 1400° in an electric furnace having a comparatively still atmosphere. (3) No appreciable change occurred in the annealing temperature or density and but very slight change in thermal expansion. G.R.S.

Experiments on the remelting of glasses of abnormal working properties. MRS. G. A. GREEN, F. W. HODKIN, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **13** [49], 64–70 (1929).—Tests were made to determine if crushing and remelting would overcome the unsatisfactory character of glass resulting in (1) using wet batch, (2) using coarse-grained limestone in batch, and (3) remelting cullet without small additions of an alkaline salt. The original batch used was sand 1000, soda ash 325, and limestone 228. In the first and second series of tests, wet batches were employed, while in the third, limestone coarser than 30-mesh was used. Cullet from the above batches was prepared by heating to 1400°, the founding period being from 21 to 22 hrs. The crushed cullet thus made was remelted alone and also with an addition of 2% sodium sulphate containing 5% of its weight in carbon. Remelting cullet from wet batches produced homogeneous glass, but its viscosity and rate of setting are still high. Analysis showed practically no change in composition. Additions of sodium sulphate to the cullet produced less viscous glass which set less quickly than the original glass from batch. In melting the batch containing coarse limestone, scummy and stony glass resulted, having a high viscosity. This cullet when crushed and remelted alone produced an easier working glass than the original. Additions of sodium sulphate produced an easy-working glass which was less viscous and slower setting than either the original or the remelted glass. G.R.S.

Influence of cullet on physico-chemical properties of glass. M. A. BESBORODOV. *Ceramics and Glass*, **5** [10], 361–62 (1929).—B. gives a description of tests and the results obtained: (1) The quantity of cullet in the batch has practically no influence on either the chemical composition, coefficient of expansion, or chemical stability of

the glass. (2) The content of cullet in the batch apparently affects the thermal stability of the glass. (3) It increases the tenacity of the glass. (4) When working on automatic machines a glass must be used in which the quantity of cullet has been carefully determined. M.V.K.

Additional note on the analysis of glasses containing phosphate. J. D. CAUWOOD, J. H. DAVIDSON, AND VIOLET DIMBLEBY. *Jour. Soc. Glass Tech.*, **13** [52], 270–79 (1929).—The removal of P_2O_5 by means of silver carbonate and silver nitrate was not satisfactory in the case of a complex glass containing P_2O_5 in amount of 5% or more. Tests were carried out in the laboratories at Sheffield and Canning Town in order to determine the conditions under which the method breaks down and to work out a procedure of more general application. Results of tests on the accuracy of the former methods are shown. The method of removing the P_2O_5 by means of ammonium molybdate, followed by removal of the excess molybdenum by lead acetate or nitrate and removal of excess lead by hydrogen sulphide appears to give satisfactory results under suitable conditions. The following suggestions are made for suitable procedures in certain cases. (1) In simple glasses free from lead and barium, the lead molybdate can be suitably precipitated in the presence of acetic acid providing the content of $Fe_2O_3 + Al_2O_3$ does not exceed 6 to 7%. (2) In glasses containing considerable proportions of iron and aluminum, hydrochloric acid should be used instead of acetic. (3) Complex glasses containing lead and barium should be treated with hydrochloric acid instead of acetic. An alternate method for the removal of molybdenum as sulphide, and one for the rapid determination of calcium are given. See also *Ceram. Abs.*, **8** [1], 22 (1929). G.R.S.

Influence of manganese oxide on some properties of glass. A. A. CHILDS, VIOLET DIMBLEBY, F. WINKS, AND W. E. S. TURNER. *Chem. News*, **140** [3643], 92 (1930). G.R.S.

Effect of the solution of alkalis from glass containers on the rate of dissociation of hydrogen peroxide. ANON. *Glashütte*, **60** [3], 39 (1930).—The rate of dissociation of hydrogen peroxide was determined by measuring the oxygen pressure formed in a glass container. No appreciable pressure could be detected at the end of a month in containers of Jena and Murano glass. L.T.B.

Velocity of crystallization in soda-lime-silica glasses. E. ZSCHIMMER. *Jour. Soc. Glass Tech.*, **13** [49], 76–85 (1929); for abstract see *Ceram. Abs.*, **8** [8], 568 (1929). G.R.S.

Rate of crystal growth in technical soda-lime-silica glasses. ADOLF DIETZEL. *Glass Ind.*, **11** [5], 106–13 (1930); translated by K. H. Lunde and F. W. Preston from *Sprechsaal*, (1929); see also *Ceram. Abs.*, **8** [12], 871–72 (1929). E.J.V.

Velocity of crystallization in soda-lime-silica glasses. K. TABATA AND E. ZSCHIMMER. *Jour. Soc. Glass Tech.*, **13** [52], 350–51 (1929).—T. suggests that for a better understanding of the influence of surfaces on the devitrification of glass as reported by Z., additional experiments are desirable. Z. replies that data on this point can be found in a paper entitled "The temperature-time curves of visible devitrification in soda-lime-silica glass." *Sprechsaal*, **58**, 110 (1927); see also *Ceram. Abs.*, **8** [8], 568 (1929). G.R.S.

Accelerating the fusion of glass. I. I. KITAIGORODSKY. *Ceramics and Glass*, **5** [10], 362–64 (1929).—The significance of accelerating the fusion of glass is discussed and tests made abroad by different investigators are outlined. M.V.K.

Strength of glass containing cracks. L. H. MILLIGAN. *Jour. Soc. Glass Tech.*, **13** [52], 351–60 (1929); *Chem. News*, **140** [3640], 46 (1930).—Experiments were made to study the travel of cracks through glass. Small glass bars were prepared from window glass which were marked across the center with a transverse scratch. Bars were

subjected to atmospheres of different types or were wetted with various liquids and the conditions of time and load under which they would break were studied. Microscopic examinations were made using ordinary and polarized light. Results showed (1) the presence of water in cracks reduced the strength by about 20%; (2) exposure in air saturated with water vapor reduced the strength considerably; (3) bars wetted and then redried before testing regained slightly more than their original strength; (4) air saturated with vapor of absolute alcohol produced an effect similar to that of air saturated with water vapor; (5) the presence of dry paraffin oil in the crack increased the strength by about 20%; (6) wetting the crack with a dilute solution of sodium silicate followed by drying increased the strength by about 20%; (7) the effect of water in decreasing the strength, and of dry paraffin oil in increasing the strength, was practically instantaneous, and these effects are thought to be physical rather than chemical in nature. G.R.S.

Further note on the fracture systems of glass. F. W. PRESTON. *Jour. Soc. Glass Tech.*, **13** [49], 3–15 (1929).—When trouble is experienced in annealing large flat sheets of plate or wire glass, causing breakage in grinding, polishing, or glazing, there is a deceptive similarity between two sorts of radiating fissures. If confused, efforts to cure the trouble may result in making the glass worse rather than better. The name "radiant" was given to the point from which a number of radiating fissures arise by multifurcation. The kinds of fissures produced in circular disks of glass are considered. In heating the central portion of a disk while the outer rim is cold, the fissure opens at the boundary between the hot and cold areas, runs in a radial direction, and forms a second radiant on the other side. The stresses are the same as if a central hole had been cut in the disk and into the hole an oversized bung had been driven. The greatest tension occurs at the boundary between the bung and the rim. Diagrams are given showing the relation between the tension in the circumferential direction and the compression in the radial direction. When the heated spot is large, extending nearly to the edge, the fissure will open at the extreme edge, the crack will fork, forming a true radiant of little explosive violence. P. discussed Guthrie's observations on the remarkable symmetry of these cracks. Cases are considered where the center of the glass disks are cold so that they tend to contract. Fissures will open in the central part, and will fork into two radiants close together. When the central chilled area is large, failure takes place under the tangential tension as before and the initial crack opens very close to the center of the plate, resulting in an explosive collapse with two radiants very close together. In rare cases the crack is a circumferential one. Superficially this sort of fracture is very similar to that produced by the bung-in-the-hole arrangement. Exactly opposite causes seem to produce very similar effects. A fracture of a radiating type, called a "tree" crack, may arise in any one of four conditions. (1) There may be a small bursting area in the center of the plate. The fracture is then a double tree with radiants well separated. (2) There may be a large bursting area in the center. The fracture then enters from the edge. (3) There may be a small contracting area at the center. If this breaks at all it will probably form two radiants close together. (4) There may be a large contracting area. If this forms a radiating fracture, it will tend to resemble (3) only with more devastating results. (2) is rare in commercial glass, and is easily recognized. (1) and (3) arising from opposite causes are similar in appearance. In the annealing leer, the center of the plate cools before or after the edges. If it cools last, the fissure starts near the center and takes the form of two trees, base to base. If the center cools first, the plate will vent from the edge when the cool center is large, but when it is small, the result will be a forked crack in the form of a double tree, with two well separated radiants. Polariscopes will not show whether the stress is due to compression or to tension. G.R.S.

Defects in glass: lack of homogeneity. C. J. PEDDLE. *Rev. belge. ind. verrières*, **1**, 31–32 (1930).—Reprinted from Peddle's "Defects in Glass." A.J.M.

Study of the devitrification of glass. I. I. KITAIGORODSKY. *Jour. Soc. Glass Tech.*, **13** [51], 219–29 (1929); for abstract see *Ceram. Abs.*, **8** [8], 569 (1929). G.R.S.

Photoelastic properties of glass. F. C. HARRIS. *Jour. Soc. Glass Tech.*, **13** [51], 213–19 (1929); for abstract see *Ceram. Abs.*, **8** [10], 718 (1929). G.R.S.

Physical properties of soda-silica glasses. I. Thermal expansion. W. E. S. TURNER AND F. WINKS. *Chem. News*, **140** [3643], 92–93 (1930). G.R.S.

Gases in glass. Part II. Gas and moisture content of glasses. A. BECKER AND H. SALMANG (translated by H. W. Howes). *Jour. Soc. Glass Tech.*, **13** [49], 98–111 (1929); for abstract see *Ceram. Abs.*, **8** [9], 643 (1929). G.R.S.

Note on formation of sodium sulphate in glass tank furnaces. W. E. S. TURNER. *Chem. News*, **140** [3643], 92 (1930). G.R.S.

Silver galvanized glass. WOLFGANG GREISER. *Glashütte*, **60** [16], 260–61(1930).—G. discusses some of the properties which a glass should possess in order to silver it properly. L.T.B.

Sediments in regenerators and waste-gas conduits in glass-melting furnaces. F. H. ZSCHACKE. *Sprechsaal*, **63** [11], 192–94; [12], 210–11; [13], 225–27; [14], 247–50 (1930).—The sediments deposited in the chambers and waste-gas conduits are among the most annoying phenomena which appear in regenerators of glass-melting furnaces. Their origin is not yet completely explained. A succession of samples of chamber and conduit sediments were chemically and mineralogically examined. The results of tests showed that volatilization and the converting into dust of frits are important causes of the sediments. Which of these two processes is the greater factor is not clearly determined. As large quantities of amorphous SiO_2 were detected the volatilization of SiO_2 was assumed. The process can be explained by the influence of H_2 (Wartenberg) and HCl or NaCl (Grosse) on SiO_2. M.V.K.

Heat-resisting steels with special reference to their application in the glass industry. R. J. SARJANT. *Jour. Soc. Glass Tech.*, **13** [50], 167–82 (1929); for abstract see *Ceram. Abs.*, **8** [5], 351 (1929). G.R.S.

Bending of glass tubes. RAYLEIGH. *Glass Ind.*, **11** [5], 105 (1930); reprinted from *Nature*.—A glass rod about $^3/_{16}$ in. in diameter was laid across two nails about 1 m. apart and loaded at the middle with 300 grams, and readings of the height of the midpoint taken over a period of seven years. The results show that glass of mature age does not bend under its own weight. E.J.V.

Perfecting the Fourcault process. ANON. *Rev. belge. ind. verrières*, **1**, 33 (1930).—Drawings show the new invention which is designed to prevent ruptures of the sides of the sheet. A.J.M.

Plate-glass manufacture by the continuous process. C. W. AVERY. *Mech. Eng.*, **52** [2], 171 (1930); for abstract see *Ceram. Abs.*, **9** [3], 172 (1930). H.W.A.

New prism glass. ANON. *Popular Sci.*, **116** [5], 48 (1930).—Prism window glass has been used before to deflect the course of light between tall buildings from a vertical to a horizontal path so that the light could penetrate room interiors. The new glass will permit the passage of approximately 22% more light because the prismatic design of its surface shifts the path of light from the vertical to the horizontal by some 20° more than the old glass did. The large prisms of the new glass are easy to clean and their bottom faces are curved to ensure wide diffusion of rays. E.J.V.

. Glass bottles as a product of material flow. ANON. *Chem. Met. Eng.*, **37** [4], 242–43 (1930).—A flow sheet shows the general course of materials through the plant of Owens-Illinois Glass Company. Sand, soda, and lime are unloaded from box cars by means of vertical bucket conveyers. From the silos these materials flow by gravity onto a

conveyer belt where they are picked up by a bucket elevator to the mixed batch storage bins in the furnace house. Electric trucks carry the packed bottles to storage and chutes. G.R.S.

Choice of annealing schedule for commercial glassware. J. B. MURGATROYD. *Chem. News*, **140** [3640], 45 (1930). G.R.S.

Theoretical glass problems of the present. E. ZSCHIMMER. *Z. angew. Chem.*, **43** [6], 122–24 (1930).—A review of some of the more important problems which are yet to be solved for a fuller understanding of the behavior of glass. L.T.B.

Problems of ancient glassware. G. W. MOREY. *Discovery*, **11**, 61–64 (1930).—The development of glass is traced and analyses of ancient glass are compared with modern glass. The formula $Na_2O{\cdot}3CaO{\cdot}6SiO_2$ is regarded as the prime glassmaking composition used through the ages. H.H.S.

Progress report of Test Section of the Standards Committee of the Glass Division. G. E. F. LUNDELL. *Bull. Amer. Ceram. Soc.*, **9** [5], 154–58 (1930). E.J.V.

Status of glass technology in 1929. ANON. *Rev. belge. ind. verrières*, **1**, 33–34 (1930). A.J.M.

Glass industry of North America in 1929. W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **13** [52], 360–97 (1929); for abstract see *Ceram. Abs.*, **8** [8], 572 (1929). G.R.S.

Storage and packing of glass objects. ANON. *Rev. belge. ind. verrières*, **1**, 30–31 (1930).—Attack of glass by atmospheric agents results in the following characteristic forms: (1) a general surface deposit which is easily removed by water; (2) the appearance of crystalline aggregates which are removable by water; (3) strongly localized attack which is removable by acetic or hydrochloric acid; and (4) general surface attack which gives a rough appearance and is difficult to remove even with hydrofluoric acid. If a glass is attacked by water and the products of successive attacks are analyzed it is found that the quantity decreases with successive attacks. The amount of SiO_2 in the products increases while the percentage of Na_2O decreases. A total attack in 4 periods of 3 hours each gave 62.3% for the first, 19.6% for the second, 13.9% for the third, and 4.2% for the fourth. The SiO_2 percentage increased from 18.4% in the first to 36.3% in the fourth while the Na_2O decreased from 61.6% to 43.6%. The decreased surface attack does not seem to be due to loss of alkali by the glass. Experiments have verified this. Fire-polished surfaces are attacked less than mechanically-polished surfaces. A fire-polished surface showed only $^1/_2$ as much attack as a mechanically-polished surface when subjected to boiling water and $^2/_3$ as much attack when a boiling 10% NaOH solution was used. Attack by the latter solution is much greater than that by boiling water. The interior surfaces of glassware show greater attack than the exterior ones due to the hardening of the latter in manufacture. In storing glassware care should be taken to exclude dust since it is hygroscopic. Care should also be exercised in choosing the proper kind of paper for packing purposes since many papers contain acid and are also hygroscopic. When using straw for packing purposes the straw should never be moistened. A.J.M.

Rapid development seen in use of glass bottles for motor oils. ANON. *Amer. Glass Rev.*, **49** [31], 21 (1930).—Definite successes by two large companies in marketing their motor oils in glass bottles is being viewed with considerable interest by the glass container industry. The experiments conducted in selected areas have proved so satisfactory that plans are under way for widening the scope of the new method. E.P.R.

Glass skyscraper for Chicago planned by noted architect. ANON. *Amer. Glass Rev.*, **49** [24], 18 (1930).—Future generations will live and work in glass houses, according to plans of Frank Lloyd Wright, noted Chicago architect. Wright now has plans

for a 23 story office building for Chicago's Loop and a vast glass hotel in Arizona. The glass skyscraper would have a frontage of 300 ft., a depth of 105 ft., and weigh one-third less than an ordinary building of the same size. Whereas, a conventional building of this size would cost about $10,000,000, it is claimed the glass building can be erected for $7,000,000. E.P.R.

Sand into glass. ANON. *Glass Ind.*, **11** [5], 101–105 (1930); reprinted from *Fortune*, **1**, 1 (1930).—A nontechnical discussion of the ingredients and methods used in the manufacture of glass is presented. It is shown how although machines replace ancient human skill, in the field of artistic glassware the craftsman still reigns supreme. The Steuben Division of Corning Glass Works employs old glassmakers and René Lalique in France keeps 600 men to crystallize his designs in art glassware. Illustrated. E.J.V.

Production begins at new Henryetta plant. ANON. *Glass Ind.*, **11** [5], 118–19 (1930); *Nat. Glass Budget*, **45** [50], 3 (1930); *Amer. Glass Rev.*, **49** [28], 27–29 (1930).—A detailed description of the new window glass manufacturing plant of the Pittsburgh Plate Glass Co., Henryetta, Oklahoma, is given. Glass is being drawn there just three hundred and ten days after the ground was broken for the factory. Illustrated. E.J.V.

Changes in the Belgian glass industry. WILLIAM C. BURDETT. *Commerce Repts.*, **19**, 382–83 (1930).—The Belgian plate-glass industry is undergoing a notable evolution both in the operating and selling fields. New methods of manufacture will probably soon be necessary. These new methods are characterized by the employment of modernized machines that will augment the minimum production of the mills. Efforts will be made to cut down costs of production in view of the tariff barriers alleged to handicap the export of plate glass. A closer agreement between producers is predicted and the concentration of production units is becoming a necessity. The window glass situation was not improved during March, and the depression also extended to the mouth-blown glass producers. Plans for a closer combination of the concerns in window glass and a single holding company to control all the Fourcault companies in Belgium are beginning to take form. E.J.V.

History of Belgian glassmaking. ANON. *Rev. belge ind. verrières*, **1**, 29–30 (1930). A.J.M.

Glass industry of Sweden. ANON. *Pottery Gaz.*, **55** [635], 808 (1930).—Production and sales in the bottle-glass industry increased from 37,000,000 in 1928 to 41,000,000 bottles in 1929. The window-glass industry has been very active owing to the increase in house building and the introduction of new ways of using window glass. The Glafva and Oxeloesund works, which produce machine-made glass, were busy during the whole year. The handmade glass works find it increasingly difficult to compete with machine-made glass. The small glass industry, which is beginning to be an important industry in Sweden, has recently founded an export agency called Svenska Glasbrukans Exportfoerening, which has proved very useful in view of the increasing demand from foreign countries. See also *Ceram. Abs.*, **9** [4], 270 (1930). E.J.V.

Glass trade in Spain. ANON. *Pottery Gaz.*, **55** [635], 834 (1930).—The production of glass in Spain has developed recently. Most of the producing concerns are included in the Union Nacional de Fabricantes de Espejos y de Cristales. The capital invested in the factories is stated to be 25,000,000 pesetas, and the number of hands engaged in them is estimated at over 3000. The members of the Union produce, for the most part, glass for mirrors, windows, doors, etc. Besides the Union named, there is another in Spain, known as the Union Commercial Vidriera, which includes the producers of mirrors and flat glass, and some special forms of glass. E.J.V.

BOOKS

Notes on the Analysis of Glasses, Refractory Materials, and Silicate Slags. Edited by W. E. S. Turner. Published by the Society of Glass Technology, Sheffield. 6s. This book consists of a series of eight papers, seven of which deal with the subjects mentioned in the title, and one with the determination of sulphur (as sulphide) in glasses. Most of the papers are followed by discussions, but these are spoiled by the absence of contributions from several chemists who have been recognized for many years as authorities on the subject of silicate analyses. Even if they could not be present at the meetings where the papers were read, a greater effort might have been made to secure their opinions in the form of "communications" on a subject of such great importance. The papers, especially the first, entitled "A Critical Survey of the Methods in Use for the Analysis of the Simpler Glasses," assume a considerable amount of knowledge of analysis on the part of the reader and that he has access to works giving fuller details. For this reason, much of the book is unsuitable for beginners or for chemists isolated from a really good chemical library. Indeed, it may be described as a series of comments by various chemists on some precautions they have found to be essential in order to secure accurate results. There is little that is novel in any of the methods proposed. Some statements, such as "a double precipitation (of lime) is unnecessary for dolomites, but is desirable for magnesites," should be taken as indicating the author's experience rather than as a general one, for some other chemists and their assistants have had the opposite experience, at any rate in their early days of their training in this particular separation. A curious series of statements as to the inaccuracies which can occur when lime is weighed as oxide appears in the discussion on one paper. Where "time is no object" the weighing of lime as oxide is quite accurate, but under works conditions, and those were assumed in the paper which caused the discussion, there is always a tendency not to ignite the oxalate sufficiently or to cool it with sufficient care to avoid absorption of moisture. It can scarcely be said that "the book supplies a long-felt want," but it should be read by all who have to make silicate analyses in order that they may ascertain whether they are taking the precautions mentioned by the authors, or are using methods regarded by the latter as objectionable. (*B.C.A.*)

Glassblowing in Scientific and Industrial Laboratories. (Le soufflage du verre dans les laboratoires scientifiques et industriels.) H. VIGREUX. Published by Dunod, Paris. 272 pp., 255 figures. Reviewed in *Chaleur ind.*, **11**, 166 (1930). A.J.M.

Finishing of Glass. (Glasveredelung). KARL HESSE. 109 pp. Published by the Akademische Verlagsgesellschaft, Leipzig, 1928. Reviewed in *Rev. belge ind. verrières*, **1**, 44 (1930).—Etching (chemical and mechanical), cutting, polishing, sandblasting, frosting, iridiation, silvering, coppering, gilding, coloring, painting, and enameling are treated. A.J.M.

Mechanical Manufacture of Glass. (Maschinelle Glasverarbeitung.) ALFRED WENDLER. Akademische Verlagsgesellschaft, Leipzig, 1929. 172 illustrations. 249 pp. Rm. 24. Reviewed in *Sprechsaal*, **63** [13], 241 (1930); *Z. Ver. deut. Ing.*, **74** [13], 416 (1930).—The book is an exposition of the important questions on the development of mechanization of the glass industry. The following subjects are treated: (1) pressing, stamping, and milling of the fused glass; (2) different systems of mechanical blowing and the machines used; (3) systems of feeding; (4) drawing of glass and machines used; (5) finishing glass objects; cutting, blasting, and fusing, and machines used. M.V.K.

Yearbook of the Czechoslovakian glass industry. (Annuaire de l'industrie verrière tchecoslovaque.) ANON. 1st ed., 1928–29. 130 pp. Written in French, German, and English. Published by Rimpler and Vogel, Haida (Bohemia). Reviewed in *Rev. belge ind. verrières*, **1**, 44 (1930). A.J.M.

PATENTS

Handling glassware. GEORGE E. HOWARD. U. S. 17,669, May 20, 1930 (reissue). Apparatus for handling and heat treating glassware to effect the annealing thereof, comprising an elongate leer tunnel, an endless conveyer belt for transporting the ware therethrough, and means disposed adjacent to the ware-entering end of the tunnel for alternatively supplying heat to or abstracting heat from the ware on the belt previous to subjecting the ware to annealing temperatures within the tunnel, the means comprising a chamber having an upper wall, over and in contact with which the belt passes, means for supplying heat to the interior of the chamber, and means alternatively for passing a cooling medium through the chamber, whereby to compensate for various temperature conditions existing in the ware when placed on the belt.

Producing glass. BERNARD LONG. U. S. 1,749,823, March 11, 1930. A violet-colored phosphate glass containing a relatively small percentage of titanium dioxide and being substantially free from silica.

Making vacuum bottles, etc. ERICH H. ROHL. U. S. 1,755,307, April 22, 1930. In combination with a sealing machine, a mold, pins arranged on the mold, scissor-like means attached to the pins, pins fastened to the other ends of the scissor-like means, the pins being guided within grooves arranged in the support, means for the mold, and a hand lever connected to the shaft of the mold.

Cutting apparatus for sheet glass. CLIFFORD A. ROWLEY. U. S. 1,755,365, April 22, 1930. An apparatus for transversely scoring a moving sheet of glass, comprising a carriage movable parallel with the movement of the sheet and including a guide bar extending transversely above the sheet, and a cutter carrier having a slidable and rotatable fit on the guide bar.

Retarding freely-falling mold charges. ALFRED R. HUNTER. U. S. 1,755,397, April 22, 1930. Apparatus for guiding charges of molten glass into a mold comprising a guiding member having a substantially vertical opening therethrough, means for directing a charge of molten glass downwardly through the opening, and means for creating an upwardly moving current of a gaseous medium through the opening for slowing up a freely falling charge of molten glass passing through the opening.

Handling glassware. WILBUR S. MAYERS. U. S. 1,755,404, April 22, 1930. In glassware handling apparatus, the combination with a movable carrier for the ware of a member movable in a closed substantially horizontal path adjacent to the carrier, the movement of the member being differential to that of the carrier, a deflector mounted on the member, and means for moving the deflector on the member into and out of the path of movement of the ware on the carrier.

Drawing glass. ARTHUR E. SPINASSE. U. S. 1,755,523, April 22, 1930. An anchoring and temperature controlling slab for use in drawing articles or sheets of glass comprising an oblong solid body portion adapted for complete submersion in a bath of molten glass and immediately beneath the meniscus of the article or sheet being drawn, the body having a transverse wedge shape and provided with an upper surface convex in both longitudinal and transverse directions.

Feeding molten glass. KARL E. PEILER. U. S. 1,755,792, April 22, 1930. Apparatus for feeding molten glass, comprising a container for the glass having a submerged lateral discharge outlet, an impeller disposed in the container, means for moving the impeller periodically toward and from the outlet, a spout block mounted adjacent to the outlet, clamps for removably securing the spout block in place, a spout projecting from the spout block and communicating with the outlet, the spout being curved outwardly and downwardly, and terminating in a downwardly opening orifice, an orifice ring mounted removably at the discharge end of the spout, an enclosure surrounding the spout, means for heating the interior of

the enclosure, and shears for severing mold charges from the glass discharged from the orifice ring.

Transparent fused pure silica. HENRI GEORGE. U. S. 1,755,953, April 22, 1930. Process for the manufacture of transparent, fused, pure silica, consisting in carefully packing a mass of siliceous sand around as large blocks as possible of quartzites, the blocks having a high chemical purity, small isometric crystalline elements closely packed without any cement and without any occluded gases, in melting the blocks and siliceous sand, and after cooling, in dividing up the composite ingot obtained along the planes containing the flaws or bubbles arising from local impurities, for the purpose described.

Manufacture of hollow-blown glass articles. SYDNEY HUNT. U. S. 1,755,957, April 22, 1930. In a machine for the manufacture of hollow-blown glass articles of the type comprising a combined open suction and blowing head and a cover adapted to be applied to the opening in the head, the cover carrying at least one plug for the formation of the preliminary blow opening in a parison; a construction including a rotary valve located between the opening in the head and the neck mold, the valve being so arranged that in one position it allows the plug to coöperate with the neck mold and the suction to be effective and in another position, when the plug and cover are withdrawn, closes the head to the outside and allows the blowing air to be effective.

Supporting and delivering viscous glass. OLIVER M. TUCKER AND WILLIAM A. REEVES. U. S. 1,756,109, April 29, 1930. (1) In a glass machine, a delivery orifice for glass, an annular ring positioned adjacent the orifice for annularly projecting a heating fluid beneath the orifice, and a cup movable into capping position with the orifice for enclosing the fluid and severing means periodically acting beneath the annular ring. (2) In a glass machine, a delivery orifice for glass, an annular perforated ring positioned adjacent the orifice, means for supplying the ring with a fluid for annularly projecting a fluid against the issuing glass, and a means acting in timed relation to the operation of the severing means for stopping the supply of the fluid.

Annealing glassware. GEORGE E. HOWARD. U. S. 1,756,244, April 29, 1930. (1) Apparatus for annealing glassware, which comprises a tunnel having a wall exposed to the influence of the outer atmosphere, means for directing heating and cooling media against the outer surface of the wall at selected intervals longitudinally thereof to control the temperature in the tunnel. (2) An apparatus for annealing glassware, comprising a tunnel having a metallic wall exposed to the influence of the outer atmosphere, means for projecting unconfined streams of a heating medium against the wall in regulable quantities at intervals longitudinally thereof to control the temperature in the tunnel.

Delivering molten glass. KARL E. PEILER. U. S. 1,756,492, April 29, 1930. Apparatus for transferring mold charges of molten glass from a glass feeder having a discharge outlet to a moving mold device, a supporting frame, a hub mounted at each end of the frame, each of the hubs carrying a pair of sprocket wheels spaced apart, a chain conveyer having upper and lower chains, the chains carried by the sprockets, a vertical bracket secured to the upper and lower chains, a mold charge transfer cup mounted on an upper extension of the bracket, means associated with the frame for positioning the cup at the outlet to receive a mold charge, means associated with the frame for inverting the cup at the mold to discharge its contents into the mold, and means associated with the mold for causing the cup to travel with the mold during the discharge of the mold charge.

Feeding molten glass. KARL E. PEILER. U. S. 1,756,493, April 29, 1930. (1) A glass-shaping die having a flaring inlet and flaring outlet meeting in a contracted neck passage provided with a fluid film lining. (2) In a glass machine, a plurality of molds movable in a closed path, a transferring or distributing receptacle for delivering sepa-

rated charges of glass to the molds and means for moving the distributing receptacle with a moving mold while delivering glass thereto and then returning the receptacle into similar delivering relation to a succeeding mold.

Multiple press head for glassware-shaping machines. CLINTON S. BUDD. U. S. 1,756,728, April 29, 1930. Glassworking apparatus comprising a rotary mold table, molds carried thereby, lugs carried by the table in advance of certain of the molds, a press head mounted to swing on a horizontal axis, a plurality of pressing plungers carried by the press head and movable successively to a position above a pressing station to which the molds are brought by the rotation of the table, a lug carried by the press head and adapted to be engaged by the first named lugs to swing the press head from a position in which one of the plungers is at the pressing station to a position where another of the plungers is at the pressing station, and a spring for returning the press head to its initial position when the lugs are disengaged.

Heat-absorbing means for sheet-glass apparatus. JOSEPH A. REECE. U. S. 1,756,798, April 29, 1930. (1) A cooler for use in sheet glass apparatus, comprising a hollow casing consisting of two compartments separated by a horizontally disposed partition, and means for passing a liquid cooling medium through the upper compartment only, the lower compartment containing a gaseous medium. (2) A cooler for use in sheet glass apparatus, comprising a hollow casing, the interior of which is divided horizontally into an upper large compartment and a lower somewhat smaller air compartment, and means for passing a cooling medium through the upper larger compartment only.

Making hollow-blown glassware. ROBERT W. CANFIELD. U. S. 1,756,813, April 29, 1930. (1) Apparatus for making hollow glassware, comprising a parison support mounted to rotate upon a permanently vertical axis, means for rotating the support, means for reheating a parison carried by the support and means for applying blowing pressure to the parison during the reheating operation. (2) Apparatus for making hollow glassware, comprising a parison mold; a pressing and blowing plunger mounted to rotate on a permanently vertical axis for forming a parison in the mold, the plunger embodying a tubular member having an air passage therein, and a central member adapted to close the air passages when in pressing position; and means for elevating the central member at the conclusion of the pressing operation to open the passage and admit blowing air to the parison.

Glassware-forming apparatus. FRANK O'NEILL. U. S. 1,758,085, May 13, 1930. (1) A bottle blowing machine including a mold provided with neck finish means including a plunger, positive means holding the plunger in the mold, power mechanism for orienting the mold, and yieldable means controlled by the mechanism for withholding the plunger from operative position when the mold is oriented. (2) A bottle blowing machine, means embodying a horizontally reciprocable slide, relatively movable bottle engaging vertical axis members suspending glass from the slide, a pneumatic control means for the slide and an additional pneumatic control means for the engaging members.

Machine for lapping, etc. GEORGE W. ANDREWS, JR. U. S. 1,758,100, May 13, 1930. Tool carrier mounted for reciprocating and rotary movements, means for reciprocating the carrier, and mechanism for imparting a partial revolution to the carrier upon each stroke thereof in one direction, the mechanism including a rotary element, means for preventing rotation of the element in one direction, means for preventing rotation of the carrier in the same direction, and means between the carrier and element whereby, when the carrier is moved in one direction, one of the elements is rotated and when the carrier is moved in the other direction the other of the elements is rotated.

Glass-polishing machine. WILLIAM E. PORTER. U. S. 1,758,534, May 13, 1930. In a glass-polishing machine, the combination with a head, of a sleeve vertically movable in the head, a fork having a shank rotatably mounted in the sleeve and supported thereby, a polishing wheel mounted on a horizontal axis in the fork, a driving shaft extending through the shank of the fork and having a driving gear connection with the wheel, a second driving shaft parallel with the first driving shaft having a driven gear connection with the first driving shaft and a driving gear connection with the fork, the gear connection permitting a relative longitudinal movement between the shafts.

Glass feeder. LEONARD D. SOUBIER. U. S. 1,759,209, May 20, 1930. In combination, a container for a supply body of molten glass, a laterally extending substantially U-shaped trough communicating at both ends with the container and having a bottom outlet opening therein, a cover for the trough, a chamber arranged between the branches of the trough and having a bottom inlet at its forward end for entry of outside air, a stack rising from the inner end of the chamber, an exhaust port providing communication between the stack and one end of the trough, and means arranged at the other end of the trough to apply heat to the glass in the trough.

Forming hollow glassware. LEONARD D. SOUBIER. U. S. 1,759,210, May 20, 1930. In a machine for forming hollow glass articles, the combination of an inverted blank mold open at its upper end to receive a charge of glass, means for applying air under superatmospheric pressure to the upper surface of the glass and thereby compacting it in the mold, a closure device movable into position to close the open end of the mold, means for expanding the glass to hollow form in the mold by air pressure supplied to the lower end of the mold, and means for maintaining subatmospheric pressure in the mold above the glass throughout the period of the expansion.

Leer roll. WILBUR F. BROWN. U. S. 1,759,220, May 20, 1930. In an annealing leer for use in sheet glass apparatus, plurality of sectional rolls, the joints of the sections of the roll being staggered with relation to the adjacent rolls.

Width-maintaining wheel. JOHN L. DRAKE. U. S. 1,759,225, May 20, 1930. In sheet glass apparatus, means for drawing a sheet from a mass of molten glass, a grooved member engaging the border portions of the sheet, and a scraper disposed within the groove.

Operating sheet-glass coolers. JOHN L. DRAKE. U. S. 1,759,226, May 20, 1930. The process of absorbing heat from a mass of molten glass or from a newly-formed glass sheet consisting in passing a stream of oil through a metallic casing in proximity thereto but out of contact therewith and in maintaining the temperature of the oil in excess of 212°F.

Operating sheet-glass coolers. JOHN L. DRAKE. U. S. 1,759,227, May 20, 1930. Process of absorbing heat from a mass of molten glass or from a newly-formed glass sheet, which consists in arranging a metallic casing adjacent thereto but out of contact therewith, in passing a stream of cooling liquid through the casing in contact with the outer side walls thereof, and in so relating the walls of the casing and the cooling liquid that the outer surface of the casing will attain to a temperature of 212°F or over while allowing the temperature of the liquid to remain below 212°F.

Producing molten glass. JOHN L. DRAKE. U. S. 1,759,228, May 20, 1930. In glass apparatus, a tank furnace construction comprising a melting tank containing a mass of molten glass, a second melting tank in proximity to the first tank, means for conveying the molten glass from the first tank to the second tank in relatively thin stream form, and means for mixing additional glassmaking materials with the stream of molten glass as it is conveyed from the first tank to the second tank.

Drawing sheet glass. JOHN L. DRAKE. U. S. 1,759,229, May 20, 1930. Apparatus for making sheet glass including a tank furnace having a slot in the bottom of its

working receptacle, the slot being of variable width longitudinally and a flow slab cooperating with the slot, as and for the purposes set forth.

Sheet-glass apparatus. LEOPOLD MAMBOURG. U. S. 1,759,235, May 20, 1930. In sheet-glass apparatus, a receptacle containing a mass of molten glass, means for drawing a sheet therefrom, a roll over which the sheet is deflected into a horizontal plane, a hood arranged over the receptacle and adapted to protect the sheet from the atmosphere during its formative period, and heat-absorbing means arranged between the hood and the roll.

Sheet-glass apparatus. LEOPOLD MAMBOURG. U. S. 1,759,236, May 20, 1930. In sheet-glass apparatus, means for deflecting a sheet from one plane to another, and means rotating within the first named means and independently thereof for cooling the same.

Cleaning glass-polishing pads. HAROLD M. BLACK. U. S. 1,759,820, May 20, 1930. A cleaning device for polishing pads, comprising a table capable of traveling movement past a polishing pad in advance of a glass-carrying table, a pad cleaning member on the table positioned to engage the polishing pad while traveling and a guide plate at the rear end of the table whose forward edge extends to a plane below the plane of the succeeding glass-carrying table and whose rear edge is disposed in approximately the plane of the glass-carrying table.

Forming vacuum flasks. G. C. MARKS. Brit. 325,717, April 16, 1930. Relates to the method of making glass vacuum flasks which consists in nesting an inner cylinder having a contracted neck within an outer cylinder, supporting the cylinders in an inverted position, and heating the lower portion of the outer cylinder until the glass becomes plastic and fuses onto the lower edge of the inner cylinder to form a sealed joint. According to the invention, the heated lower portion of the outer cylinder is forced to assume the shape of the neck of the vessel prior to the formation of the sealed joint.

Glass manufacture. L. BACHMANN. Brit. 326,593, May 7, 1930. Relates to vessels such as vials, tablet tubes, test tubes, etc., which are made from glass tubing, and consists in forming such an article so that the bottom is thicker than the wall of the tube from which it is made. The bottom forms with the wall of the article, a sharp edge on the exterior, while the join on the inside is rounded. In another construction, the bottom is formed with a flange. In other constructions, the bottom may be convex or concave instead of being flat, and it may be impressed with a mark. The article is made by closing the end of a tube by drawing out the glass in the usual way, and then blowing the hot glass into contact with a mold plate.

Annealing furnaces. T. TEISEN. Brit. 326,636, May 7, 1930. In a continuous furnace for annealing glass, etc., having a heating zone, an intermediate zone at a lower temperature, and a final cooling zone, the return lap of the conveyer passes through a tunnel beneath the furnace, and above and below this in the intermediate zone are heating flues. The gases flow around the high-temperature zone through floor and roof flues, and side wall flues obstructed by baffles. At the end of the zone the gases pass to the flue and then through dampered passages to the lower flue, along which they travel to the chimney. The return lap of the conveyer may be further heated before it enters the heating zone by a flue in the end wall, and a flue beneath the heating zone portion of the tunnel. The intermediate and final cooling zones are made of metal, and the hotter part of the former may be covered with heat-retaining brickwork.

Heavy Clay Products

Recovery of pillars in clay mining. CLYDE AUGSBERGER. *Bull. Amer. Ceram. Soc.*, 9 [6], 179–89 (1930).—After a brief review of the history of former operations and the general layout of a mine, the methods used in National Mine No. 21 at East

Canton, Ohio, are described in detail. The plan of the mine, panel layout, and the removal of an individual pillar are described with illustrations showing how more than 80% of the clay is recovered. Conditions and results in a number of other mines are given with illustrations of the methods. The relation of a high percentage of extraction to costs and safety is discussed.

Operating properties in clay mining. H. E. NOLD. *Bull. Amer. Ceram. Soc.*, **9** [5], 140–45 (1930); for abstract see *Ceram. Abs.*, **9** [3], 183 (1930).

Construction and operation of a special diamond core drill for exploring shale deposits. V. W. BOEKER. *Bull. Amer. Ceram. Soc.*, **9** [5], 145–49 (1930); for abstract see *Ceram. Abs.*, **9** [3], 183 (1930). E.J.V.

Scientific research on bricklaying at Mellon Institute. ANON. *Architecture*, **41** [4], 255 (1930).—A brief description of the investigation covering all aspects involved in bricklaying. G.R.S.

Production of salt glaze by application of slip to the ware. J. OTIS EVERHART. *Jour. Amer. Ceram. Soc.*, **13** [6], 399–403 (1930); for abstract see *Ceram. Abs.*, **9** [3], 182 (1930).

Salt glazing. ANTON VOGT. *Clay-Worker*, **93** [5], 351 (1930).—The supposed origin of salt glazing is explained. The loss of the gloss of the glaze is often due to the sulphur from the remaining fires and clinkers in fireholes attacking the glaze. This defect occurs mostly with clay high in alkalis, and the proportion of silica, alumina, and oxide of iron is not correct. The only remedy is to draw the fires and clinkers soon after the last salt. A suggestion for improving the glazing is offered. E.J.V.

Simulative service tests for glazed building materials. J. OTIS EVERHART. *Jour. Amer. Ceram. Soc.*, **13** [6], 404–10 (1930); for abstract see *Ceram. Abs.*, **9** [3], 181 (1930)

Improvement of clay ware by coating with engobe. A. E. BUCH. *Tonind.-Ztg.*, **54** [31], 526–27 (1930).—An engobe is a thin coating of clay or clay mixture applied to a fired or nonfired body and is used to give a uniform appearance to brick or to change the color of a surface. The engobe must have the same properties as the ground clay with regard to shrinkage and expansion. Clay rich in alumina and with an average iron and lime content gives pale yellow or brown colors; clay rich in iron gives a red color; manganese gives brown and black. Chemical coloring agents may be used for the engobe: iron oxide for red, cobalt oxide for light and dark blue, copper oxide for green, rutile for yellow, chromoxide for green, and manganese oxide for brown to black. Fluxes are used: soda, feldspar, and glass, to lower the vitrification temperature. The oxide admixtures are added in a powdered state in a watery suspension and afterwards sifted. Preparation of the engobe is very important; it must be diluted very carefully with pure water. The consistency of the engobe should be verified from time to time. If it does not adhere to the body an addition of dextrine is necessary. The setting and firing of the molded articles is the same as of glazed brick. A brick coated with an engobe is stable against weather and frost. M.V.K.

Making lightweight products by addition of coal or coke. G. A. BOLE. *Brick Clay Rec.*, **76** [9], 582 (1930).—Manufacturers are attempting to reduce the weight of brick and tile by the addition of a combustible material to the raw clay batch. Some are grinding coal or coke with the shale or clay in the dry pan. Separate grinding and screening of the combustible before mixing with the clay dust is preferable. From 25 to 50% (by volume) of coal or coke can be added, depending upon the clay; the more plastic clays will work with higher percentages of combustible. The coal or coke acts as a grog, reducing lamination in a clay column. The ware containing coal or coke will dry more rapidly and safely. The weight of the resultant product will be from 60 to 75% that of the ware without combustible additions. This addition decreases the strength of the fired ware materially and increases the absorption. Firing is the

only difficult point in the process of making a lightweight product by this method and great care must be exercised. The difficulty of firing will vary directly with the amount of combustible added. In this method of producing lightweight ware, coke is preferable to coal for two reasons: (1) the volatile matter has been burned out, and (2) any pyrite present has been oxidized. Low volatile coal will give less trouble during firing than high volatile coal. Combustible low in ash with high fusion point is ideal but not essential. E.J.V.

Reducing weight of brick. H. H. KENYON. *Brick Clay Rec.*, **76** [8], 524 (1930).—Three $1^1/_8$-in. holes in a brick would take out enough material to reduce the weight from one-third to one-half pound. Figures are presented showing how this saving mounts up when figured on the basis of a regular daily production. It is followed from the pit, where it affects mining and raw clay transportation costs, into one plant where considerable power can be saved in grinding operations, etc. Drying, setting, and firing costs will be reduced, as will trucking costs. Some objections that may be raised by the consumers are discussed and ways in which they may be met are pointed out. E.J.V.

Color fired into face brick. A. F. GREAVES-WALKER. *Brick Clay Rec.*, **76** [9], 573–75 (1930).—If good reds are to be obtained the iron in the clay must be kept in the ferric condition throughout the firing period after red heat is reached. As a rule the most brilliant red colors are produced in a clay when it is brought to vitrification, the iron exerting its maximum coloring power when the mass has reached the viscous stage. Flashing is simply reduction of the iron and is brought about by admitting insufficient air through the fires to bring about complete combustion of the fuel gases. Red firing clays vary widely in their ability to take a "flash" that will produce good blacks, browns, and other colors. They all vary in the amount of reduction required. Green and yellow colors produced with zinc on red firing clays have been popular for several years past. As in the process of salt glazing, in zinc glazing the ware must be carried to vitrification before reaction between the zinc and the clay can properly take place. In zinc glazing, the zinc vapor combines with the silica, alumina, and iron of the clay to form a zinc-aluminium silicate, the iron playing the part of a coloring oxide. Some odd and pleasing brown effects can be produced on red firing clays by using ground kiln ashes or cinders. No brick has remained so popular or has remained in style so long as the Colonial sand-faced brick. Manganese has been used in Europe for a number of years to produce chocolate browns. Manganese chloride appears to give the best results, used in finely powdered form. E.J.V.

Firing clear red brick without flash. ANTON VOGT. *Clay-Worker*, **93** [4], 282 (1930).—A clay or shale free from soluble salts which cause scum, and having a sufficient percentage of oxide of iron to produce a dark red color is necessary. The oxide of iron in clay or shale is in the ferrous state in the first stages of firing, changing later to the ferric state by oxidation, producing during incipient vitrification and near vitrification from a light to a dark red color. To fire without flash the bagwalls should be high to protect the brick around the bagwalls and to avoid smoky flash-producing fires; for the more fire brick in bagwalls become red hot, the more the smoke will be burned up, avoiding any possible smoke. The method of firing is to fire every other furnace from the time the brick begin to shrink, and wait until any smoke disappears from the stack, then fire the other furnaces, the other half of the kiln, and before firing, raise the damper, and when the inside of the kiln shows entirely clear, lower the damper until the fires just draw in, still giving air over the fires, and maintaining a soaking heat. This will get the heat to the bottom and not overfire the top and around the fires. E.J.V.

Use and abuse of building brick. A. M. GILES. *Brit. Clayworker*, **39** [456], 19–24

(1930).—G. opens with a brief history of building brick followed by a discussion on the origin, composition, and physical properties of clays used in building brick. The most injurious impurity is limestone, though a small percentage is considered an advantage since it assists vitrification. Shrinkage to a large extent depends on tempering. During drying and firing, shrinkage should not exceed 8%. Drying occurs below 250°F, dehydration or watersmoking below 1300°F, oxidation between 1300°F and 1650°F, vitrification between 1650°F and 2200°F. Cooling or annealing should be carefully done. Considerable discussion is included on such tests of brick as specific gravity, absorption, transverse strength, crushing stress, and pier crushing, as well as on water proofing and efflorescence. R.A.H.

New process of producing vitrified ceramic products. J. B. SHAW AND M. C. SHAW. *Popular Sci.*, **116** [5], 50 (1930); *Ceram. Ind.*, **14** [5], 556 (1930); see also *Ceram. Abs.*, **9** [6], 427 (1930). E.J.V.

Rôle of drying in the formation of efflorescences. ANON. *Tonind.-Ztg.*, **54** [26], 443–44 (1930).—Tests are described which were made to ascertain the effect of drying on the formation of efflorescences. Several hundred pieces made from tile clay were fired at a 5a Seger cone and slowly dried for four weeks outdoors during a damp autumn. They showed clearly white gypsum efflorescences. They were smoked and fired at 80°C. The tile showed dirty melted crusts but soluble salts were not detected. Three hundred more tile were prepared from the same clay mass and dried in a drying chamber for 5 days at a temperature of 75°C, then smoked and fired with the first group of tile. Only a few of the pieces artificially dried showed any efflorescences or melted crusts. The experiments showed that rapid drying reduces discolorations and prevents efflorescences in dried ware. M.V.K.

Rapid manufacture of fireclay brick. OTTO EGGERT. *Tonind.-Ztg.*, **54** [21], 358 (1930).—Six days sufficed for the production of 120 pipe blocks weighing from 2 to 5 kg. each. The first day the forms were prepared; they were shaped and dried in half a day in a warm place and in half a day in a hot kiln. The third day the blocks were set in the kiln in a special manner and the kiln was lighted. It was a kiln 5 m. in length, 4 m. in width, and 3.60 m. in height, and was provided with 3 fire boxes on each longitudinal side. In 12 hrs., full fire was given. After a total firing of 30 hrs. the necessary temperature of Seger cone 8 was reached. The sixth day the fired blocks were delivered. M.V.K.

Dimensions of hollow masonry building units. ANON. *Commercial Stand. Monthly*, **6** [10], 319 (1930).—The A.S.T.M. Committee on Hollow Masonry Building Units has expanded the scope of its work to include the preparation of standards for concrete masonry building units. A new subcommittee on dimensions of hollow masonry building units has been organized. The function of this subcommittee is to bring about correlation between the sizes of masonry units and of masonry openings, so that all will fit together with proper bond and little or no cutting. The present standards for such products as brick, hollow tile, concrete blocks, door frames, and window frames have been established separately and usually without considerations as to how the various products might be combined in the structure. E.J.V.

New finishes for brickwork. BERTON ELLIOT. *Popular Sci.*, **116** [5], 106–107 (1930).—Fireplaces, mantels, chimneys, and interior brick surfaces may be modernized in various ways to harmonize with new decorative schemes. Brick can be finished in practically any shade or tint desired. Stains and dyes of various kinds can be used for this purpose. Glazed, shaded, and plastic effects can be obtained. Ordinary house paints, shingle stains, water soluble aniline stains, cold water paints, and special concrete wall paints can be used. E.J.V.

Valve for oil-fired furnaces. ANON. *Brick Clay Rec.*, **76** [9], 598 (1930).—The

valve is a plug type designed for either manual or automatic operation. The valve lever is locked in position with a key furnished with the valve and this key is also used to adjust the valve position for desired oil flow, very minute changes in positions being possible with the finely threaded adjusting screw. Dial plate and index shows the amount of valve opening at all times and permits quickly duplicating a previous valve setting. Further details of valve construction and operation are given. Illustrated. E.J.V.

Influence of moisture alterations on building materials. ANON. *Tonind.-Ztg.*, **54** [7], 109–11 (1930).—The physical and chemical actions of water in masonry walls are discussed. M.V.K.

Excess of barium carbonate in brick. ANON. *Tonind.-Ztg.*, **54** [7], 111–12 (1930).—Different tests made to ascertain the effects produced by an excess of barium carbonate (5%) in brick are described. The results indicated that: (1) if the barium carbonate is finely diffused through the mass it has no injurious effects in the fired brick; (2) local accumulations of $BaCO_3$ formed no soluble salts but only discolorations and deformations of the surface. M.V.K.

Recent improvements in methods of brickmaking. ALFRED B. SEARLE. *Brit. Clayworker*, **38** [455], 467–68 (1930).—The erroneous idea, prevalent for several years, that houses could be built more cheaply of concrete than of brick, has almost completely disappeared, and with an increasing demand for beauty in color as well as in the form of modern houses, the use of brick has correspondingly increased. S. discusses modern methods of excavating clays and shales, the machines used for forming the clay into brick, humidity driers, uses of waste heat, and the manufacture of rustic and tapestry brick. The manufacture of brick from shale and nonplastic materials such as sand, slag, destructor refuse, colliery waste, concrete, silica rock, magnesite, zirconia, and with sillimanite is discussed. R.A.H.

Brick pavements best by every test. ANON. *Clay-Worker*, **93** [4], 286–87 (1930).—Paving brick is coming more and more into its own as the facts are being more widely circulated as to its superior quality as a paving material. There are many miles of excellent brick road in this country over 30 years old which are practically as good as new. England and Holland have good brick roads one hundred or more years old. The manufacturers of Illinois have presented statistics and facts and figures from a technical and engineering standpoint which prove that a properly constructed brick pavement is not only as smooth and safe a road as it is possible to build today, but due to its longer life and smaller maintenance costs, is the less expensive road, over a period of years and is, therefore, a basically sound and economical road investment for the taxpayers. Pennsylvania, Ohio, Indiana, and Iowa have been building the smoothest and finest roads in the world out of paving brick. E.J.V.

Iron pipes vs. clay pipes for drains. ANON. *Clay-Worker*, **93** [4], 301 (1930); translated from *Ziegel-Zeit.*—In Halle, Germany, 40 years ago, clay pipes about $7\frac{7}{8}$ in. in diameter were used for soil pipe, which are today as good as new and do not show the least trace of deterioration. Cast-iron pipe serving similar drainage purposes and laid in the same manner were completely destroyed in 18 years. Geological influence was answered in the negative: the cast-iron pipes showed clearly and conclusively that the destruction process proceeds inside. For draining the ground of surplus water and for town sewerage, clay pipes are decidedly superior. E.J.V.

Drying of brick. GUSTAV STRECK. *Tonind.-Ztg.*, **54** [13], 203–207 (1930).—Some drying installations work satisfactorily in one place and not in another due to the difference in behavior of clays during drying. Sensibility of clays to drying is influenced by the size and the shape of the particles of clay substances; the smaller the particles the more difficult the drying. Clays require uniform drying of the whole body to pre-

vent a premature drying of the surface. The process of drying can be divided into 3 periods: (1) heating and uniform warming up to 50 to 60°C without drying the surface; (2) predrying at a constant temperature but with only a small reduction of the humidity content of the air till the end of the shrinkage; and (3) final drying with a raised temperature and reduction of humidity. The duration of these three periods varies; the longest is the predrying and the shortest is the final drying. The sensitivity of the raw materials to drying depends also on the kind and method of the preparation of the body. Clays can be thinned down with additions of fine sand or brick powder. S. gives a detailed description of the German drying plants and systems. M.V.K.

Coloring and hardening process for iron slag brick. ADAM SASSUR. *Pit and Quarry*, **19** [13], 70 (1930).—S. has applied for a patent upon a process for brick manufacturing that requires no firing and uses slag from iron furnaces as raw material. Iron slag, granulated by water-cooling, is received in dumping cars from the steel mills. The screened slag goes into a hopper which holds about 15,000 lbs. From the hopper it goes into a drum-mixer. To this is added 2 to 3% lime, 2 to 2½% calcium sulphate (gypsum), and 3 to 5% magnesian limestone which contains 50% $CaCO_3$ and 50% $MgCO_3$. A steam pipe leads into the mixer to heat the materials, especially during cold weather. It is best that the material be warm when it is pressed into brick. If the material is too dry, water must be added, as the moisture required is 10 to 12%. From dry pans it slides through chutes to the presses and is pressed into brick. The brick are taken from the presses and put into the iron kiln, 20,000 to 30,000 brick in a kiln. The kiln is closed tightly and the brick are subjected to a steam pressure of 100 to 300 lbs. They remain there 8 to 10 hours, and then the steam is withdrawn. Brick made under this process were tested after their making and the average compressive strength was 4600 lb. per sq. in. Brick made by the above process are a light Bedford in color. To obtain a light-red to dark-red brick, 5% ferruginous quartz (red jasper) and ½ to 2% red iron oxide are added to the above mixture when it is put into the mixer. To obtain a yellow, 5% ferruginous quartz (yellow jasper) and 1 to 2% siderite (carbonate of iron) are used. For a brown brick, 1% brown limonite and 1 to 1½% ferro-manganese are used. This coloring costs only from $0.30 to $1.00 for 1000 brick, withstands the curing process much better than does a chemical coloring, and the cost is much less. The brick are uniform in color; the edges are straight and sharp; they are highly resistant to acid; are not so readily attacked by water; absorb water 50% more slowly than brick manufactured by other processes; and not one brick out of 100,000 is lost because of imperfect manufacture. The manufacture of these brick is clean; there is no dust or odor, and clay pits are unnecessary. The fuel cost is low, as one ton of soft coal will produce 25,000 brick in a plant with an output of 100,000 brick per day. E.P.R.

Improvement in sand-lime brick machinery. E. D. CHURCH. *Pit and Quarry*, **19** [13], 51–52 (1930).—There has been a great improvement in sand-lime brick machinery and in the quality of the product. An up-to-date plant is nearly automatic, which greatly reduces the labor cost. A brief comparison of accomplishments is as follows: (1) from a press capacity of 2000 brick per hour to a capacity of 3600 per hour; (2) to a complete duplication of all parts of machinery of the same type; (3) automatic preparing, proportioning, and handling mixture, which practically removes the danger of the man who forgets. From the old form of hydrating lime from day to day and the necessity of carrying a large stock of quicklime which deteriorates very rapidly from air slaking, as compared to the new method of hydrating a carload at a time, or if desired, enough for a year's run at one time. E.P.R.

Evolution of a modern auger machine for brick. E. G. G. *Rev. mat. constr. trav. pub.*, No. 244, pp. 8–12B (1930). A.J.M.

Record year in Canadian sand-lime brick industry. ANON. *Pit and Quarry*, **18** [12], 61 (1929).—Production in the Canadian sand-lime brick industry established a new record in 1928. Output in the year amounted to $1,112,466 compared with $939,991 in the previous year and $629,672 in 1926. Production included 82,271,000 sand-lime brick. The balance of the output consisted mainly of hollow building blocks. Eleven plants were operated in the year under review. E.P.R.

Acme Brick Co. ANON. *Brick Clay Rec.*, **76** [8], 504–11 (1930).—One of the finest face brick plants in the southwest is that of the Acme Brick Co. at Perla, in central Ark. The most recent unit includes a natural gas-fired tunnel kiln and a waste-heat drier using the rotary circulation principle in which the ware is dried in 7 hrs. Among the points of interest are the method of winning clay in the pit, the huge storage facilities, the drag line used in the storage shed, their calcining plant, and other points of interest. Illustrated. E.J.V.

Cream buff stippled tile. ANON. *Brick Clay Rec.*, **76** [8], 532 (1930).—The Clay Products Co., Inc., Brazil, Ind., is marketing its newest creation in structural wall tile, cream buff stippled, Ar-Ke-Tex tile, which introduces a color blend adaptable to a wider range of architectural and decorative effects than any other shade developed. This finish is impervious to the action of oils, greases, acids, or alkalis and cleans easily with soap and water. E.J.V.

Milliken Brick Co. ANON. *Clay-Worker*, **93** [5], 346–49 (1930).—A tour through the interesting plant of the Milliken Brick Co., Wilkinsburg, Pa., where high quality face brick are made by economical methods and delivered in unit form is described. Details of equipment and plant construction are given. Illustrated. E.J.V.

Unique brick plant. H. L. LONGENECKER. *Brick Clay Rec.*, **76** [9], 585–86 (1930).—The common brick plant of Louis Isenhour, Colon, S. C., is composed of modern mechanical equipment linked up with native inventions built by Isenhour, which enable the owner to operate the plant smoothly, personally acting as mill foreman, head fireman, and loading foreman. Among the unique features are the driers, and the type of kiln construction used. The two units have capacities of 20 and 40 M daily. Illustrated. E.J.V.

World-famous Indianapolis Speedway. ANON. *Clay-Worker*, **93** [5], 335–37 (1930).—A good example of the durability, strength, safety, and economy of brick paving is the Indianapolis Motor Speedway, which through twenty-one years of service has stood the severe test of these annual races. A detailed description of the construction is given. Illustrated. E.J.V.

Skintled brickwork. ANON. *Bldg. Econ.*, **6** [4], 9 (1930).—Skintled brickwork's invasion of the small home field seems on its way. It is about the least expensive of all the various types of masonry. E.P.R.

History of brick apartments. ANON. *Bldg. Econ.*, **6** [4], 4–8 (1930).—America's earliest apartment houses were the homes of the ancient cliff dwellers, hewn out of the soft rock of the canyons and mesa walls in New Mex. and Ariz. Their successors in the development of the apartment were the Pueblo Indians. To them is ascribed the making of the first adobe brick. Fashioned by hand from a clay peculiar to that region these brick were roughly squared and well sun-dried. The apartment as we know it today was several centuries in developing. Probably the first approach to it was in Washington, D. C. in 1794. E.P.R.

Old Ursuline Academy at Galveston. ANON. *Bldg. Econ.*, **6** [4], 15 (1930).—The Ursuline Convent and Academy, partly built in 1854 and added to in 1861 and 1900, is probably the most outstanding of all the older structures in Texas. It is claimed by experts who have made a careful examination of the building that it includes every

known brickwork design of the Renaissance period. Common brick from the famous Cedar Bayou district of Texas were used in all of the buildings. E.P.R.

America's oldest jail is built of brick. ANON. *Bldg. Econ.*, **5** [12], 14 (1930).—The Old Colonial prison, at Williamsburg, Va., has been in active service for nearly 200 years. E.P.R.

Early brickwork in old England. FRANK JAY. *Bldg. Econ.*, **5** [12], 4–8 (1930).—Roman brick from their early structures were salvaged for the construction of many of England's most notable old buildings. Earliest known brick are those found on the sites of the ancient cities of Babylonia. Well-fired brick of dried clay were made by the Babylonians more than 6000 years ago. The Israelites made brick in Egypt, but these were sundried. The great wall of China, commenced about 210 B.C., was constructed partly of brick. The walls of Athens were the most important brick structures in ancient Greece. The Romans became masters of the art of brickmaking and revived the manufacture of brick about the beginning of the Christian era. They carried their knowledge and their methods throughout western Europe, and there is abundant evidence that they made brick extensively in Germany and England. Although brickmaking was thus introduced into Britain nearly 2000 years ago, the art seems to have been lost for several centuries. It was not until the 13th, 14th, and 15th Centuries that brick came into general use again. E.P.R.

Use of hollow block in Germany. ANON. *Clay-Worker*, **93** [5], 342–43 (1930); reprinted from *Ziegelwelt*.—Nothing new in the shape of brick has been so well received on the Continent in recent years, as the so-called "one-hand" double hollow block. The chief advantages of this new block, which has rapidly attained popularity, are the ease with which it can be handled, the saving of mortar and labor in laying, the speed with which it can be produced, and the facility with which it can be used in conjunction with ordinary brickwork and for cheapening the cost of construction. These new block not only reduce the cost of laying, but they produce warmer structures, because the hollow portions have a greater heat-insulating value than solid brick. The mechanism used in producing the brick is described. E.J.V.

Brick interiors in German churches. ANON. *Bldg. Econ.*, **6** [4], 12–14 (1930).—America has been using brick since the first kiln was fired near Salem, Mass., 300 years ago, but, the real beauties and possibilities of brickwork are in Europe. Germany has used brick for every type of construction. A history of its development is given. Several illustrations are shown of interiors of German churches where the brick have been laid with greater care than ordinarily. Special shapes have been made of ornamentation which show the beauty of brickwork when artistically done. In a few instances in recent years American architects have finished church interiors in natural brick, but this is not customary. E.P.R.

Ancient brick tombs uncovered in Egypt. ANON. *Bldg. Econ.*, **6** [4], 10–11 (1930).—Royal Mastaba of some yet unidentified king was protected by outer walls of brick within which were many burial niches. The tomb constructed of stone, evenly laid, is about 320 ft. long by 160 ft. wide. It dates from the same period as the great pyramid of Meydum, that is, in the Fourth Dynasty or about 2800 B.C. E.P.R.

PATENTS

Making brick. WILLIAM B. ALCORN. U. S. 1,757,229, May 6, 1930. Method of imparting a rough texture to brick consisting in longitudinally advancing a clay bar from which the brick are to be cut, distributing particles of a combustible material to a top face and to the sides of the bar in the course of its advance, applying pressure to the particles through a further advance of the bar, to embed them in the faces of the bar, and subsequently burning out the particles to secure a pitted effect upon the faces to which the particles were applied.

Manufacturing brick. ALEXANDER BONNINGTON. U. S. 1,758,026, May 13, 1930. That improvement in methods of manufacturing scum-free brick, etc., which comprises combining with the brick clay the residue from roasted or reduced barytes ore or natural barium sulphate.

Treating clay, etc. A. L. MOND. Brit. 326,236, April 30, 1930. In processes for rendering insoluble soluble sulphates contained in clays and like argillaceous materials by means of barium compounds, the reaction is accelerated by the addition of soluble chlorides such as sodium chloride, particularly when employing barium carbonate or barium fluosilicate as the barium compound. Efflorescence in brick, tile, and like products manufactured from such clays is thereby avoided.

Refractories

Terms used in refractories industry. ANON. *Refrac. Jour.*, **5** [55], 252 (1930).—*Kaolin.* All slightly plastic clays of great purity. China clay is the most important member of the series. *Quartz.* The general name given to the common crystalline or vitreous variety of silica. Massive or vein quartz constitutes the largest part of the production. *Quartzite.* A rock made up of grains of sand. It is one of the most useful forms of silica and is the raw material for virtually all the silica refractories. *Diatomaceous Earth.* The name given to the siliceous remains of diatoms, minute aquatic organisms. The term is also applied to kieselguhr, infusorial earth, fossil flour, tripoli, and celite. Used chiefly for insulating purposes. *Seger Cones.* Used to determine the firing of a kiln. Made of a mixture of china clay, feldspar and quartz. They are small tetrahedral pyramids about $2^1/_2$ in. high and are placed in certain positions in a kiln where they can be viewed from without through a sight-hole. The cone gradually bends over as the temperature of the kiln rises and when the tip of a certain cone touches the base of the support the heating of the kiln is considered complete. *Holdcroft's Thermoscope Bars.* A similar device to Seger cones. They consist of numbered bars supported at their ends. When the desired temperature has been arrived at they sag at the middle. E.P.R.

New refractory. ANON. *Elec. Rev.*, **106** [2732], 658 (1930).—There has recently been put on the market a special high-temperature cement, "Grefco," marketed by John LeBoutillier, Ltd. "Grefco" is claimed to be free from sodium silicate and other active fluxes and has a fusion point of over 3400°F. Its use in prolonging the life of brickwork in power house boilers and where cutting action of gases is severe, will be of great advantage. E.P.R.

New refractory. SOC. ANON. DES ÉTABLISSEMENTS A. VALUV. *Refrac. Jour.*, **5** [55], 272 (1930); for abstract see *Ceram. Abs.*, **9** [4], 289 (1930). E.P.R.

New type of refractory material. SPRENGER. *Refrac. Jour.*, **5** [55], 272 (1930); for abstract see *Ceram. Abs.*, **9** [4], 289; [6], 441 (1930). E.P.R.

Effect of the continued remelting of cullet in sillimanite and fireclay vessels. A. A. CHILDS, V. DIMBLEBY, H. W. HOWES, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **13** [52], 296–303 (1929).—The glass selected for the tests had the following composition. SiO_2 74%, CaO 9%, and Na_2O 17%. Meltings were carried out both in sillimanite and in fireclay pots. Two series of meltings were carried out, the first being made from batch. The results indicate that (1) the repeated remelting at 1400° in open vessels in a gas-fired furnace results in a progressive reduction in the alkali content, not only relatively (due to the introduction of other constituents as the result of solution of refractory materials), but absolutely (due to volatilization). (2) Molten glass, as distinct from melting batch, is distinctly corrosive of both sillimanite and fireclay vessels under conditions which do not involve the flow of the glass due to ab-

straction for manipulative operations. (3) Sillimanite appears to be distinctly more resistant to molten glass than is fire clay under like conditions of use. Negative results were also of value; for the fact that no physical tests on the glass could be attempted in view of the changes in composition due to volatilization of alkali on one hand, and corrosion of the pot material on the other, indicating clearly how careful one must be in attempting to interpret changes in the properties and working characteristics of glasses made under commercial conditions. G.R.S.

Insulation of heated and cooled surfaces. J. S. F. GARD AND R. S. ROBINSON. *Chem. and Ind.*, **49** [10], 125 (1930).—Qualities required of a heat-insulating medium are (1) low heat conductivity, (2) low specific heat, (3) low specific gravity, (4) mechanical strength, (5) reasonable security against fire, (6) absence of corrosive action (in wet and dry condition) on surfaces in contact, (7) resistance to alternating conditions of high and low temperature, wetness and dryness, (8) stability under required temperature conditions, (9) for low-temperature work where humidity conditions prevail an absence of capillarity is desirable, otherwise absorption of moisture greatly impairs the insulating value. The physical conditions influencing the transfer of heat in a nonconductor are discussed. A mathematical consideration of heat transmission in general is given. A series of curves are given showing heat loss in B.t.u. per sq. ft. per hr. for fire brick $4^1/_2$, 9, and $13^1/_2$ inches thick, with no insulation; also insulated with 1, 2, 3, $4^1/_2$, and 9 in. of nonpariel brick, the temperatures of the inside face of the fire brick varying from room temperature to 2500°F. G.R.S.

Sillimanite. E. F. FERRARI. *Refrac. Jour.*, **5** [55], 272 (1930); for abstract see *Ceram. Abs.*, **9** [4], 287 (1930). E.P.R.

Refractory materials in the cement industry. K. ENDELL. *Zement*, pp. 1154–58 (1929); *Refrac. Jour.*, **5** [55], 272 (1930).—Silica clay bonded and magnesia refractories have been extensively studied. Their resistance to heat and thermal expansion up to 1600°C have been determined together with their behavior during quenching. The results are summarized in graphical formation. See also *Ceram. Abs.*, **9** [4], 284 (1930). E.P.R.

Refractories. P. P. BUDNIKOFF AND B. A. HISCH. *Refrac. Jour.*, **5** [55], 272 (1930); for abstract see *Ceram. Abs.*, **9** [2], 108 (1930). E.P.R.

Some properties of silica brick. L. LONGCHAMBON. *Rev. mat. constr. trav. pub.*, No. 244, pp. 5–8B (1930); *La Céramique*, **32**, 219–23 (1929).—L. discusses the raw materials, the quartz inversion, influence of alkalis, influence of alumina, thermal expansion, and refractoriness of siliceous products. Very pure quartz (99.9% SiO_2) was ground and then pressed into samples after the addition of Na_2CO_3. The samples were fired for 2 hours at 1250°C and the densities were determined. The densities for from 0.1 to 0.7% Na_2O were, respectively, 2.55, 2.41, 2.37, 2.34, 2.32, 2.30, and 2.30. The decrease in density shows the transformation of quartz to tridymite and cristobalite. The same experiment was performed with 0.5% Na_2O and 0.5, 1.2, and 3% Al_2O_3. The densities were, respectively, 2.50, 2.55, 2.57, and 2.30. It is evident that Al_2O_3 diminishes the speed of inversion of quartz and opposes the action of the alkalis. The thermal expansion of a sample of silica brick is always less than that which is calculated from the mineralogical composition. If the sample is pulverized, however, and again pressed into a specimen, the expansion is increased and agrees more closely with the calculated one. This has been determined by many repetitions of the experiment. L. states that each crystal of SiO_2 in a silica brick is covered with a silico-calcareous cement and that the softening of such a brick at high temperatures is due to the fusion of the cement. A.J.M.

Sillimanite, cyanite, andalusite, and dumortierite. ALICE V. PETAR. Bur. Mines, *Information Circ.*, No. 6255, 19 pp. (1930).—The minerals, andalusite, cyanite, and

sillimanite differ in physical properties but have the same chemical composition. They are silicates of alumina having the formula $Al_2O_3 \cdot SiO_2$. Another mineral closely related to this group is dumortierite. The report gives a brief description and properties of the minerals, together with the history, uses, mining, preparation, and occurrence. In the U.S., the commercial production of these minerals commenced in 1920, but practically no statistics are available. These minerals are mined in Calif., Nev., Va., and N. C., in this country and mainly in British India abroad. A list of possible producers and buyers is attached and a fairly complete bibliography is included. R.A.H.

Refractory mortars. O. PHILIPP. *Chem. Fabr.*, pp. 86–88 (1930).—A mortar for refractory brickwork must have sufficient adhesion when first applied and also must have, after firing, a porosity no more than that of the brickwork, so that slags are not formed. The first requirement is satisfied by the use of fire clay or, if refractory oxides are used instead, by the addition of a binder such as sodium silicate, dextrin, etc. The second requirement demands that the working temperature shall lie above the sintering temperature of the mortar, but below the softening point. In many cases it is necessary to lower the sintering temperature by addition of salt, sodium silicate, asbestos, etc. Refractory mortars for very high temperatures are usually composed largely of the material of the brickwork finely ground and mixed with a cement such as bentonite. Another cement addition is a mixture of starch, powdered glass, and crushed quartz. (*B.C.A.*)

New chromite cement developed for high temperature use. ANON. *Rock Prod.*, **33** [8], 79 (1930); see *Ceram. Abs.*, **9** [5], 352 (1930). W.W.M.

Power plant refractories. ANON. *Blast Fur. Steel Plant*, **18** [4], 681 (1930).—Causes of premature failure of refractories are (1) erosion by slags and fluxes, (2) cracking or spalling, (3) lack of refractoriness, (4) shrinkage or expansion in use, (5) softening under load, and (6) mechanical abrasion or fracture. F.P.H.

Manufacture of glasshouse refractories at Buckeye Clay Pot Co. ANON. *Ceram. Ind.*, **14** [5], 525 (1930).—A short description is given of the recent improvements in processing glasshouse refractories at the plant of the Buckeye Clay Pot Co. A better block was obtained by pugging the body three times. The tank block machine is under high vacuum at all times. Comparison of fired block made with the new and old pugging process and with and without the use of vacuum shows those now made are over 5% heavier. This shows that more clay and less voids are contained in the vacuum-made block. F.P.H.

Standardization of the quality of refractory blocks. E. LUX. *Tonind.-Ztg.*, **54** [10], 158–61; [11], 179–81; [13], 207–208 (1930).—(1) Material for specific gravity determinations should be average samples of the entire substance and not a sifted portion. For silicate blocks a pulverizing to 0.5 mm. suffices; fireclay brick, especially those with a vitrified structure should be pulverized very fine. After pulverizing, the sample must be deferrized by a magnet. Other tests are described. M.V.K.

Temperature, heat flow, and storage in coke-oven walls. ANON. *Gas Age-Rec.*, **65** [16], 552 (1930).—The temperatures of various portions of silica and fireclay coke-oven walls are measured at 1-hr. intervals during a run, and from these the heat flow through and storage of heat therein are calculated. The thermal conductivity of silica walls must be greater than that of fireclay walls, since (at about the same surface temperature) (1) the time required for the completion of coking is about one-third less in the silica-lined batteries, (2) heat flow through the silica walls is greater, and (3) temperature distribution over the silica walls is more uniform (also causing a briefer time for complete coking). Since the product heating value X gas quantity should be held constant, systematic supervision of the temperatures in the heating flue is necessary; as in most coke plants this value varies while the gas quantity remains about constant

By means of this supervision the time required for a coking run is cut 12.5% in an oven lined with silica, and 20% in one lined with fire clay. F.P.H.

Sagger symposium. ANON. *Ceram. Ind.*, **14** [5], 530–37 (1930).—The following questions are discussed by various plant executives: (1) How does the method of setting ware affect the life of saggers and breakage? (2) How does setting of saggers in tunnel and periodic kilns both with the single and double banjos affect the life and breakage? (3) What size of grog is found particularly effective in the manufacture of good saggers and also what percentage of fines seems to give best results? (4) Do open- or tight-firing clays give best results? (5) In what way does the drying of saggers affect their life and breakage? A. V. Bleininger discusses these questions. F.P.H.

Dielectric strength of porcelain and pressed paper. H. HANDREK. *Keramos*, **9** [5–6], 163–72, [7], 209–14 (1930).—The errors frequently present in the determination of the dielectric strength of materials are pointed out and their remedies suggested. The following subjects are discussed in detail: (1) form and dimensions of test pieces, (2) shape and arrangement of electrodes, (3) electrical properties of the immersion liquids and their effect on the determination of the break-down potential of insulators, (4) variation of break-down potential with thickness and shape of test pieces, (5) temperature coefficients of the dielectric strengths of porcelain and pressed paper, and (6) theory of electrical conduction at elevated temperatures. F.P.H.

Preparing grog for fire brick. ANON. *Brit. Clayworker*, **39** [456], 14 (1930).—The ever-increasing stringency of the conditions in which fire brick are used has compelled manufacturers and others to pay more attention to grog. The temperature to which grog is fired varies with the quality of the grog required; it should never be less than Seger cone 9, and for the best grog cone 14 or 19. Uniformity of heating is important, or the grog from different parts of the kiln will have different properties. The grog particles should be sharp and angular, not rounded. Half-fired grog is useless and a frequent source of trouble. R.A.H.

Improving the quality of clay alumina brick. ANON. *Brit. Clayworker*, **39** [456], 31–32 (1930).—Salmang and Goeth investigated brick made of various mixtures of clay and alumina (bauxite) and found (1) the specific gravity of the brick varies with both the alumina content and the finishing temperature in the kiln. (2) If the brick are fired without any load, the porosity is increased by adding alumina to the clay. (3) When fired under pressure, the porosity is reduced, the greatest reduction being in the brick richest in alumina. (4) All the mixtures showed the same behavior, but those with a molar alumina were the most refractory. (5) Mixtures of clay and alumina in proportions corresponding to mullite soften first when reheated to the original kiln finishing temperature. Hence by firing at a sufficiently high temperature, almost any softening point below 1630°C could be obtained. (6) Firing under pressure appears to increase the amount of crystals formed. (7) The resistance to spalling is increased by firing under pressure especially when mixtures corresponding in composition to mullite are used. (8) Mixtures of china clay and alumina of the same composition as mullite soften at a higher temperature than mixtures of other clays and bauxite having the same composition. (9) The effect of slag on the brick depends chiefly on the porosity and only to a minor extent on their chemical composition. R.A.H.

Refractory brick. A. JAESCHKE. *Engineering*, **129** [3349], 390–92 (1930).—Refractories are defined and the requisites of refractory materials are discussed under the following heads: (1) softening and melting points, (2) resistance to large and rapid temperature fluctuations, (3) resistance to chemical corrosion, (4) liability to change of shape and volume during service, (5) thermal conductivity, (6) uniformity of composition and quality in manufacture, (7) resistance to mechanical stress in the hot and cold states, (8) ease of dressing for constructional purposes, (9) exact and uniform di-

mensions, and (10) smooth and plane surfaces. The characteristics of chief types of refractory brick are taken up. The discussion includes quartzite brick, fireclay brick, bauxite, sillimanite, magnesite, and silicon carbide brick. A.A.

Notes on silica brick and refractory mortar. ANON. *Refrac. Jour.*, **5** [53], 196 (1930); for abstracts see *Ceram. Abs.*, **8** [10], 740, 747 (1929). E.P.R.

After-expansion and true specific gravity of silica refractories for carbonizing plant. A. J. DALE, H. T. S. SWALLOW, AND F. WHEELER. *Gas Jour.*, **187**, 200–203 (1929); for abstract see *Ceram. Abs.*, **8** [10], 743 (1929). (*C.A.*)

Standardized testing methods for refractory materials in Germany and in other countries. L. LITINSKY. *Die Messtechnik*, **6** [1], 3–5 (1930).—A review of the various countries that have standardized testing methods for their refractory materials is given. Some of the methods are enumerated. E.J.V.

Silica refractories for coke ovens. RICHARD RICHARDS. *Colliery Guardian*, **140** [3601], 36–38 (1930); see *Ceram. Abs.*, **9** [3], 199 (1930). E.J.V.

Use of silica in coke ovens. F. C. DIXON. *Colliery Guardian*, **140** [3605], 416–18; for abstract see *Ceram. Abs.*, **9** [6], 437 (1930). E.J.V.

Equilibrium of refractory roof arches. R. HUSTIN. *Chaleur ind.*, **11**, 131–32 (1930).—A study of silico-aluminous refractories showed that the thermal expansion may increase when load is applied to some brick while it may decrease with a different brand. A.J.M.

Linings for cupola furnaces. ANON. *Brit. Clayworker*, **39** [456], 13 (1930).—Refractories to meet the requirements of cupola furnace linings should have (1) a high refractoriness both intrinsically and under load; (2) a high resistance to sudden changes in temperature to avoid spalling; (3) a high resistance to abrasion by the scouring action of the contents of the furnace; (4) a high resistance to any chemical reagents contained in the slags produced from the molten metal; (5) as constant a volume as possible under all changes of temperature. It is impossible to obtain any refractory material in which all these qualities are at a maximum and some compromise must be effected when selecting brick for lining cupolas. When selecting brick for lining cupolas, the effects of the changes they undergo in use should not be overlooked. Highly porous brick, when new, have a low resistance to abrasion, but after one or two heats in a cupola they have absorbed sufficient slag to impart a highly resistant surface to the brick, thereby making them much more durable. Brick which disintegrate when heated in an atmosphere of carbon dioxide gas are almost unaffected by this gas in a cupola because of the slag having sealed the superficial pores. Super-refractory brick are not necessary since the hottest part of the cupola seldom reaches 1500°C. Brick should be accurate and radial or arch shaped so that the thinnest possible joints may be used in laying. Cupola brick are easily spoiled by exposure to rain or frost. R.A.H.

Plastic linings for cupolas. G. H. ZIRKER. *Foundry Trade Jour.*, **41** [48], 399 (1929); *Chem. Abs.*, **12** [12], 887 (1929); *Refrac. Jour.*, **5** [55], 242–47 (1930); for abstract see *Ceram. Abs.*, **8** [12], 887 (1929). E.P.R.

Refractories for the cupola. C. E. BALES. *Refrac. Jour.*, **5** [55], 238–42 (1930); for abstract see *Ceram. Abs.*, **8** [11], 819 (1929). E.P.R.

Refractories for fire boxes. B. N. DOMONTOVICH. *Refrac. Jour.*, **5** [55], 272 (1930); for abstract see *Ceram. Abs.*, **9** [4], 284 (1930). E.P.R.

Refractory linings of cement kilns. MÜLLER. *Zement*, pp. 1274–77 (1929); *Refrac. Jour.*, **5** [55], 272 (1930).—Experiments recently carried out in Germany have shown that the presence of fluorspar considerably increases the rate of deterioration of the refractory linings of cement kilns. The fluorine constituent of the fluorspar plays an important part and is probably largely responsible for the deterioration, due to the fluorine entering into new combinations with the iron and aluminum. E.P.R.

Electric furnace lining. DORSEY A. LYON AND EDWIN R. COX. *Queensland Govt. Mining Jour.*, **30** [10], 422 (1929).—L. and C. remark in a recent patent specification that it is well known that no refractory lining has yet been devised for an electric furnace which does not become a fairly good conductor of electricity at the temperature of the electric crucible, and that the heat-resisting properties of the usual refractory lining, such as fire brick, have about reached their limit in a blast furnace; wherefore, if to the heat which the walls receive by direct radiation and conduction from the melting zone, there be added heat generated by stray electric currents passing through the walls of the crucible, the life of the lining is very short, the refractory material being rapidly melted down and passing away into the slag. E.P.R.

Canadian magnesite industry. ANON. *Chem. News*, **140** [3647], 149–51 (1930).—Quebec magnesite deposits are dolomitic in character, the lime introduced causing most steel men to look upon the product with disfavor. Demand for magnesite was such that the industry expanded rapidly, the value of annual exports rising to over a million dollars. After the war Austrian magnesite was again available at a low price, and difficulty was experienced in marketing the Canadian magnesite. Researches carried out at the metallurgical and ceramic laboratories of the Dominion Department of Mines have been concerned chiefly with the lime content. One method was to reduce the lime content, the other was to render it inert. Carefully controlled calcination of the crushed rock rendered the magnesite soft and friable while the impurities remained hard and strong. A light crushing operation pulverized the magnesite and the coarse impurities were removed by screening. The second method if feasible, is to be preferred, permitting the fullest utilization of the rock. The dolomitic magnesite possesses the property of "setting" at temperatures readily attainable, while Austrian or other "pure" magnesites require a very long period to burn in, and are at best a heterogeneous mixture. The improved product is selling in the U.S. at a price considerably above that of competing refractories, the market previously lost being more than regained. Considerable increase in plant capacity has been necessary to meet the increased demands. New uses are indicated as follows: (1) plastic magnesia suitable for stucco and flooring composition, (2) material for making magnesium bisulphite liquor for use in the manufacture of sulphite pulp, and (3) refractory brick. Researches are being continued. G.R.S.

Magnesite industry in province of Quebec. A. J. LANIGAN. *Blast Fur. Steel Plant*, **18** [4], 676–81 (1930).—Carbonate of magnesia as found in this district generally is brilliantly white in appearance but is sometimes gray or brown in color due to disseminated impurities. It is heavier and harder than calcite and contains from 7 to 10% lime. The mineral resembles dolomite. F.P.H.

Spread of refractory industries through middle and southern Germany. BENNO SCHMIDT. *Feuerfest*, **6** [2], 27 (1930).—A detailed account of the distribution of the industries in this section of Germany. L.T.B.

BOOKS

Course of Temperature, Heat Stream, and Accumulation of Heat in Walls of Coke Ovens. (Temperaturverlauf, Wärmefluss und Wärmespiecherung in Koksofen Wänden). MICHAEL STEINSCHLAGER. Stahleisen, Düsseldorf. 8 pp. Rm. 1.20. Reviewed in *Tonind.-Ztg.*, **54** [28], 485 (1930).—These questions have a great practical significance for the efficiency of the firing of a coke oven, the reducing of the time, and improving the quality of the coke. By measuring the temperatures in the fire clay and silica brick walls of a coke oven, diagrams of the heat flow and the accumulation of heat were obtained. The silica brick had a much greater thermal conductivity. M.V.K.

Researches on Sintering of Refractory Materials. III. Sintering of Magnesite. (Untersuchung über die Verschlackung feuerfester Stoffe. III. Die Verschlackung von Magnesit). R. MIKSCH AND HERMANN SALMANG. Stahleisen, Düsseldorf. 6 pp. 0.90 Rm. Reviewed in *Tonind.-Ztg.*, **54** [28], 485 (1930); *Stahl Eisen*, **49**, 1724–25 (1929); for abstract see *Ceram. Abs.*, **9** [5], 357 (1930). M.V.K.

Blast Furnace Practice. Vol. III. Operation and Products. FRED CLEMENTS. Ernest Benn, Ltd., London. Price 63s net. Reviewed in *Engineering*, **129** [3344], 192 (1930).—The concluding volume constitutes a comprehensive survey of present practice with valuable indicators of future development. For Vols. I and II see *Ceram. Abs.*, **8** [12], 897 (1929). A.A.

Knowledge of Ceramic Properties of Lime, Alumina, Silica, and Other Refractory and High Refractory Materials. (Zur Kenntniss der keramischen Eigenchaften von Kalk-Tonerde-Silikaten und anderen feuerfesten und hoch feuerfesten Materialien). E. BERL AND FR. LÖBLEIN. Berlin, 1930. 28 pp. 15 illustrations, 5.00 Rm. *Tonind.-Ztg.*, **54** [28], 485 (1930); *Z. Ver. deut. Ing.*, **74** [11], 349 (1930).—The ceramic properties of various mixtures of the pure components CaO-Al_2O_3-SiO_2 were studied by heating them in a gas furnace. The following conclusions were drawn: (1) The mechanical strength depends on the SiO_2 content and is greater the more complete the conversion of quartz to cristobalite. (2) In high SiO_2 mixtures, softening under a load of 2 kg./cm. occurs suddenly; the softening point is higher the greater the content of SiO_2 or Al_2O_3; an increase of CaO causes a decrease of mechanical strength and an increase of porosity of the body. (3) The greater the SiO_2 content the greater the sensitivity to temperature changes. (4) The basic mixtures are least resistant to chemical attack, principally because they are relatively more porous. (5) The true specific gravity gives an indication of the change of quartz to tridymite and cristobalite; this change is more complete the higher the temperature and the longer the burning period. The presence of Al_2O_3 and CaO increase the speed of the change. (6) The heat conductivity was measured by a special method which is explained fully. The greater the SiO_2 content the greater the conductivity; increasing the Al_2O_3 at the expense of the SiO_2 decreased the conductivity. The value was lowest at a composition 95% Al_2O_3, 3% SiO_2, and 2% CaO. The conductivity of high Al_2O_3 clays does not vary appreciably with the temperature while that of high SiO_2 and Dinas clays does. Kieselguhr has a low heat conductivity which is independent of the temperature. Up to 1000°C the heat conductivity is greater the greater the density, while the higher the temperature the less the insulating effect of the pores of a body. L.T.B.

Change of Quartz into Tridymite in Silica Brick in the Presence of Mineralyzers and a Partial Substitution of Quartzites by Sand in a Silicate Bed. P. P. BUDNIKOFF AND I. C. SMELJANSKY. *Research Inst. Silicate Ind.*, [Charkov], **2**, 51 pp. (1929).—(1) An addition of Marten slags to the batch aids the transformation of quartz into tridymites. (2) A 1% admixture of Marten slags to the batch produces silicates with a low specific gravity; 2% admixture increases the quantity of tridymite but also increases the specific gravity; 3% raises the content of tridymite but the specific gravity is also raised. (3) An addition of more than 3% did not increase the content of tridymite but increased the specific gravity. It was also found that an addition of about 25% sand instead of quartzite does not lower the properties of silica brick and with a suitable firing these change into tridymite. M.V.K.

Fireclay Bodies. A coöperative investigation by the State Ceramic Research Institute and by the Staff of the Lenzos Glassworks. *Trans. Ceram. Research Inst.*, [Moscow], **16**, 299 pp. (1929).—Steps are being taken to rationalize the glass industry in U.S.S.R. and to make use of the enormous quantities of Russian resources instead of importing raw materials from abroad. The research work done by the Institute

includes the following problems: (1) the size of the fireclay grains, (2) temperature of firing, (3) the quantitative proportion of clays and grog in the batch, (4) the nature and properties of clays (clays of Latnaja and Tschassow-Jar were chosen) including: diluting water, plasticity, air shrinkage, firing shrinkage, porosity, absorption of water, real specific gravity, apparent specific gravity, mechanical solidity, sensitiveness to temperature alterations, refractoriness under pressure, and action of fused glass and microstructure. 7R. M.V.K.

PATENTS

Porous molded body to be used in diffusion, filtration, etc. JOSEF MÜLLER. U. S. 1,742,411, Jan. 7, 1930. Making porous bodies, comprising mixing finely subdivided refractory material with a bituminous binder, molding under pressure at a temperature approaching the melting point of the binder, allowing the molded body to cool down, reheating same to a temperature above 300° and not exceeding 400°C and allowing it to cool slowly.

Calcined bauxite. FRANCIS C. FRARY. U. S. 1,756,425, April 29, 1930. Process of calcining bauxite, comprising crushing the bauxite, and by the substantially complete combustion of carbonaceous fuel mixed therewith, heating the bauxite and by such heating driving off free and combined water and without substantial reduction of nonaluminous material fitting the pieces of bauxite together to a coherent coarsely porous mass substantially free from carbon.

Manufacture of objects consisting of refractory, insulating, abrasive, etc. MARCEL FOURMENT. U. S. 1,756,457, April 29, 1930. Process of baking objects of tubular form of a refractory and dielectric substance, by placing a piece of conducting heat-resisting material capable of being heated to a high temperature by induced currents in the interior of the tubular object to be baked, in leaving a space between the piece and the object to be baked, thereafter heating the piece by means of induced electric current to a temperature sufficient to bake the object.

Furnace. ARTHUR F. HALL. U. S. 1,756,485, April 29, 1930. A block unit for walls consisting of a molded body of refractory heat-insulating material and a reinforcing metal skeleton embedded in the body, the skeleton being made with bars disposed at the surface of the body and constituting corners of the block.

Refractory block. PAUL G. WILLETTS. U. S. 1,758,903, May 13, 1930. A wall for glass furnaces for contact with the molten glass therein comprising a plurality of refractory block having interengaging corrugations parallel to the glass-contacting face of the wall to form tortuous joints between the blocks, the corrugations in the joints between superimposed courses of block having contacting surfaces adjacent to the glass-contacting face of the block which extend downwardly, whereby to minimize the erosive action upon the block of the upwardly moving gases evolved from the molten glass when it penetrates a short distance into the joints.

Method of protecting a refractory article. RICHARD H. MARTIN. U. S. 17,661, May 13, 1930 (reissue). A refractory article comprising a body of bonded refractory grains and a relatively thin protective coating thereover and bonded thereto composed in large part of magnesium compound, the protective coating being substantially impervious to kiln gases under normal operating conditions.

Furnace roofs. WILD-BARFIELD ELECTRIC FURNACES, LTD., AND L. W. WILD. Brit. 325,548, April 16, 1930. In an electric furnace the roof brick are grooved at their edges and are carried by one-piece flanged ties supported adjacent the outer casing of the furnace. The ties are flared at their lower ends to provide flanges extending over substantially the whole width of the pair of brick supported thereby, and are also flanged at their upper ends to engage pairs of spaced bars. Channels may be formed in the brick to take electric resistors.

Furnace walls and linings. A. REPPMAN. Brit. 326,245, April 30, 1930. The lining of a rotary or other cylindrical furnace or kiln is formed of brick detachably held by inwardly extending rings which are connected by spacing members to form a rigid framework. Each ring is formed of a number of sections spaced apart at their ends to leave gaps, and their inner edges are made of fishtail form to engage the complementarily shaped ends of the blocks. The spacing members for the rings of sections consist of flanged frames, which are spaced apart circumferentially, and are staggered in adjacent rows. The brick are each stepped on one face and the plane abutting faces are inclined. Any one of the brick can be replaced by removing a frame, the underlying insulating brick, and the wedging brick of the pair. Cooling spaces are formed by the brick and the fishtail ends of the members and these spaces are in communication with the atmosphere through gaps between the insulating brick registering with the gaps in the rings.

Refractory substances containing crystalline alumina. CARBORUNDUM CO., LTD. Brit. 326,279, April 30, 1930. Refractories having a crystalline structure, *e.g.*, fused alumina, are rendered more resistant to spalling by bonding with another material having an interlocking crystalline structure and which preferably possesses a coefficient of expansion approximately the same as that of the bonded material. Calcium titanium oxide, magnesium titanium oxide, and mixtures of magnesium oxide and calcium fluoride or magnesia, lime, and silica are given as examples of bonding materials for fused alumina. In an example refractory pieces consisting of 95% fused alumina bonded with 5% $CaTiO_3$ (perovskite), and fired to 1450°C, lose less than 20% of their weight after alternately heating to 1350°C and quenching in an air blast twenty times.

Refractory substances. CARBORUNDUM CO., LTD. Brit. 326,560, May 7, 1930. A composite binder for a refractory material has constituents soluble in each other in varying proportions so that it continuously matures over a temperature range of at least 300°C for some interval between 1150°C and 1900°C. Preferably the melting point curve of the binder approximates to a straight line in the temperature range and the refractory material and binder are stable under reducing conditions above 1300°C and below 1600°C. Refractory materials are for example alumina, silicon carbide, magnesite, or magnesia spinel, and composite binders, according to the invention, are mixtures of alumina and fluorspar, of magnesia and calcium fluoride, and of diopside ($CaMg(SiO_3)_2$) and forsterite (Mg_2SiO_4).

Terra Cotta

Method of measuring strains between glazes and ceramic bodies. H. G. SCHURECHT AND G. R. POLE. *Jour. Amer. Ceram. Soc.*, **13** [6], 369–75 (1930); for abstract see *Ceram. Abs.*, **9** [3], 204 (1930).

Tilestones satisfy modern demands. ANON. *Brick Clay Rec.*, **76** [8], 534 (1930).—The new Tilestones, produced by The Peebles Roofing Tile Co., Portsmouth, Ohio, offer a relief from the drab monotony and relieved flatness of ordinary paving and flooring materials for porches, sun rooms, garden walks, and terraces. It is a decided modern material and answers the prevalent demand for a combination of form and a blending of colors to accentuate the motif of house and garden. Many different pattern effects are possible, or beautiful effects can be obtained with the rubble design, accomplished by breaking the tile and then setting the broken pieces in the most effective way. Tilestones are individually cast from patterns that reproduce the natural markings of genuine stone slabs. They are kiln fired and the genuine ceramic colors are part of the body of the tile itself. The base color may be red, blue, brown, green, buff, black, or fire-

flashed; any one base color may be high-lighted with any one or any combination of the other colors. These are applied to the molded clay before firing. The surfaces are not glazed, therefore, peeling and crazing are impossible. Illustrated. E.J.V.

Gold brick. PERRY G. LINDGREN. *Clay-Worker*, **93** [5], 345 (1930).—In making gold terra cotta trim for building purposes, gold as colloidal gold is applied to glazed terra cotta before the tile is entirely cooled and a second firing follows to fix the gold. There are three buildings using gold trim. E.J.V.

Interpreters of modern architecture clay products. ANON. *Brick Clay Rec.*, **76** [9], 576–77 (1930).—Photographs of some outstanding examples of the use of various colored brick and terra cotta in modern buildings are presented, with detailed discussions of each particular example. E.J.V.

BOOKS

Preparation and Properties of Fused Basalt. (Herstellung und Eigenschaften von Schmelzbasalt). KARL RISSE. Stahleisen, Düsseldorf. 4 pp. Rm 0.60. Reviewed in *Tonind.-Ztg.*, **54** [28], 485 (1930).—The difficulty of shaping and the tendency to weather of natural basalt make it useless as building material in many cases. Only by remelting was a valuable building material obtained. The experiments and improved processes for fusing basalt at the plant in Linz are described. Without admixtures the basalt is fused and cast into forms. After cooling they are annealed. With such a treatment basalt obtains a fine crystalline structure which is nonporous and free from glass. The significant improvement of the physical properties, especially of the resistance to pressure and durability, and the capability of shaping it as required make basalt an outstanding building material. M.V.K.

Manufacture of Stoneware Pipes. (Die Herstellung der Steinzeugröhren.) W. SCHUEN. Published by Tonindustrie-Zeitung, Berlin. Price 5s. S. considers that for good stoneware pipe the clay should have a sintering point between cones 1 and 6, and a refractoriness not less than cone 28. A suitable behavior when heated under pressure is also important. The various methods of manufacture used in Germany are briefly described and illustrated. and various precautions are mentioned. Drying by means of moist air heated artificially is recommended. There is a chapter on "firing" and "salting," with several useful illustrations. S. strongly recommends the use of a kiln fitted with a regenerator or recuperator. A short chapter on the causes of defects is well worth reading, and to those with the requisite knowledge, a chapter on the silicate chemistry of stoneware is interesting. R.A.H.

White Wares

Casting of sanitary ware. ANON. *Brit. Clayworker*, **39** [456], 17 (1930).—Each clay or body must be treated individually because very small variations may make a large difference in the amount of soda or other liquefying agent required. Some clays contain small proportions of soluble sulphates and others contain organic and other acids which prevent the normal use of soda from producing a good slip. These impurities can usually be rendered harmless. The clays which require more than the simple addition of soda to make them liquid can invariably be made into good casting slips if their colloidal properties are examined. A satisfactory casting slip drops readily from a spoon or other container, yet it does not resemble most liquids and differs from them in setting to a jelly. The slip should constantly be stirred or agitated until ready for casting. The consistency can be controlled by measuring the specific gravity. R.A.H.

High-voltage insulators. HOBART M. KRANER. *Glass Ind.*, **11** [5], 117 (1930).—The development of high-voltage insulators was traced. Limiting factors in the development of line insulators are enumerated, and the construction of various types of insulators, etc., is explained, important features of each being stressed. The design of insulators is important down to the last detail as the material is subject to such high stresses, and the necessity of keeping the overall length of a string of suspension insulators down to the minimum possible, results in severe taxing of the designer of the insulator. Porcelain, like glass, is about 20 times as strong in compression as in tension; it has a modulus of elasticity of a very similar order, 11,000,000 lb./sq. in. In most cases, glazing the porcelain increases its strength. Steatite is apparently somewhat stronger than either porcelain or glass, but it cannot be glazed satisfactorily as the glaze combines with the body. Charts were given showing the resistance of various porcelains, sillimanites, steatites, and glass to bending, thermal shock, etc. E.J.V.

Insulator and conductor in one substance. K. B. MCEACHRON. *Popular Sci.*, **116** [5], 36 (1930); *Ceram. Ind.*, **14** [5], 546 (1930); see also *Ceram. Abs.*, **9** [4], 290 (1930). E.J.V.

Standard insulator tests. ANON. *Commercial Stand. Monthly*, **6** [10], 318 (1930).—A proposed standard for insulator tests and ratings on power-line insulators for voltages exceeding 750 has just been completed in its development by a special committee sponsored jointly by the N.E.M.A. and the A.I.E.E. E.J.V.

Method for the measurement of the viscosity of porcelain. C. W. PARMELEE AND A. E. BADGER. *Jour. Amer. Ceram. Soc.*, **13** [6], 376–85 (1930); for abstract see *Ceram. Abs.*, **9** [3], 209 (1930).

Andalusite minerals important in making spark plugs and refractories. ANON. *Bull. Amer. Ceram. Soc.*, **9** [5], 169–71 (1930). E.J.V.

Change in volume of fired clay bodies during use. ANON. Bur. Stand., *Tech. News Bull.*, No. 156, pp. 34–35 (1930).—Supplemental to the study on experimental bodies and individual clays conducted at the Columbus branch of the Bureau, the Washington laboratory studied the expansion due to adsorbed moisture of 16 brands of commercial semivitreous ware. Tests on specimens taken from plates of 5 brands, and which had been stored in the laboratory for several months, showed that from 0 to 0.6% expansion had taken place. The plate which had undergone no expansion had 2.0% absorption while the absorption of the other 4 samples ranged from 9.4 to 12.5%. Specimens of the 16 brands of plates treated under 150 lbs./sq. in. pressure in water at 182°C were all badly crazed. Expansion taking place ranged from 0.05% from the body of 2.0% absorption to 0.4% for a body of 11.0% absorption. R.A.H.

Solubility of feldspars in water. C. W. PARMELEE AND A. J. MONACK. *Jour. Amer. Ceram. Soc.*, **13** [6], 386–92 (1930); for abstract see *Ceram. Abs.*, **9** [3], 210 (1930).

Some common defects in glazes and their cure. ANON. *Brit. Clayworker*, **39** [456], 15–16 (1930).—One of the commonest defects is the tendency of the glaze to peel, scale, or roll into tiny balls. If applied to a biscuit body, the glaze may be too plastic or too finely ground. A glaze not sufficiently plastic may peel or roll; this can be remelted by a little clay or dextrin. Some glazes peel or roll when applied to dusty ware, to articles with grease spots due to perspiration, oil, or grease, and to goods with slight scum or soluble salts. A glaze does not adhere well to a biscuited article because it is not sufficiently porous or because the texture is too coarse. In the early stages of firing if the glaze peels or rolls the remedy is to raise the temperature more slowly. If fired in too smoky an atmosphere glazes containing lead may be reduced. Polishing before glazing often causes rolling or peeling of the glaze unless gone over with a damp sponge before glazing. Badly made or worn molds will cause defects in glazed goods. Unfired ware should not be too dry when glaze is applied. When peeling is

confined to the arrises or corners of the goods, it may be due to soluble salts. Cast ware is difficult to glaze satisfactorily if more than 0.2% of soda or water glass is used. Many defects in glazes are due to lack of care in keeping the composition of the glaze uniform by constant stirring. R.A.H.

Plant of Lenox, Inc. RALPH BROWNE. *Ceram. Ind.*, **14** [5], 538–40 (1930).—A short description is given of the plant and process of Lenox, Inc., manufacturers of chinaware. The raw materials, clay, feldspar, and flint are precisely proportioned by weight, and after a preliminary dry grinding are fine ground in especially designed pebble mills. As an indication of the care exercised in the proportioning, the water used is added by weight, and the mills run a definite number of revolutions (registered by an automatic counter). This grinding takes 50 hrs. and produces a "slip" of creamy consistency. This is forced under pressure through a 200-mesh screen, and is passed over a specially designed magnetic separator to the aging vats where the plasticity is brought to the desired point. After aging the slip is ready for casting on the jiggering machine. When the raw shapes have been completed they are stored in a special drying room for 24 hrs., after which they are again placed on the wheel and sponged and brushed to remove any trace of roughness. This is done on commercial ware as well as on the most elaborate pieces produced. Three especially designed muffle kilns are used for bisque firing, each 16 ft. wide, 32 ft. long, and 12 ft. high. These kilns are gas-fired, 14 burners being used to each kiln. A temperature schedule is closely followed. The heat is gradually raised until at the end of 45 hrs. a temperature of 2200 °F is reached. Indicating and recording pyrometers are used, four thermocouples being installed in each kiln. They are located about 3 ft. from the top and 1 ft. from the bottom; one pair near the front and the other pair near the back. Too high a temperature would fuse and warp the ware and too low a heat would give underfired products. The bisque is hand-dipped in a specially prepared glaze, delicately brushed to remove any drops and dried. There are five glost kilns, all oil-fired and full muffled, each with seven burners. They are 11 ft. wide, 20 ft. long, and 10 ft. high. Continuous record is made of the oil pressure at the burners. The kilns are raised to the critical temperature of 2100 °F in 22 hrs. and cooled on a definite schedule requiring 48 hrs. Four principal methods of decorating are used; acid-gold, flat-gold, color, and dry-ground laying. Color may be done free-hand. Outlines may be applied from steel plate patterns or transfer designs may be used. This last type of ware is often further embellished by hand work. An electric decorating kiln is used. Accuracy is required in raising and maintaining the desired temperatures in the kiln, and in cooling it after the proper temperature has been reached. F.P.H.

Softer colors in crockery. ANON. *Crockery and Glass Jour.*, **108** [4], 14 (1930).—Subdued tones such as delicate green, yellow in tints ranging from topaz to light chartreuse, blue, pink, and pearly gray will outlast the demand for more brilliant colors in china and earthenware. E.P.R.

Colored insulators. ANON. *Elec. Rev.*, **106,** 195 (1930).—At a joint meeting of the Overhead Lines Assn. and the Councils for Preservation of Rural England, it was agreed that overhead lines must be used in rural districts, but should be unobtrusive. Colored insulators are practicable and less conspicuous than white porcelain. H.H.S.

BOOK

Porcelain. (Das Porzellan). R. RIEKE. Max Jänecke, Leipzig, 1928. 158 pp. 7.50 M. *Feuerfest*, **6** [2], 29 (1930).—The book was written with the viewpoint of improving the quality and reducing the price of porcelains. Methods of testing, properties, and latest developments in methods of manufacture are included. L.T.B.

PATENTS

Glazed nonvitreous pottery. JOSEPH WILLIAM MELLOR. U. S. 17,656, May 6, 1930 (reissue). Process for the manufacture of glazed nonvitreous pottery and particularly glazed porous bodied tile and glazed porous bodied electric fittings which consists in forming the body of the usual composition, adding thereto a flux which acts at a temperature below that represented by Seger cone 01 A (1080°C) and in quantity not exceeding the equivalent of 3% of the weight of the unfired body, applying to the unfired body a glaze normal for making glazed porous bodied tile, glazed porous bodied electric fittings, and firing the product in a glost kiln.

Finishing insulator shells. WILLIAM HENRY SMITH. U. S. 1,755,308, April 22, 1930. In an apparatus of the character described, in combination, a vertical shaft adapted to be rotated, a plate mounted on the shaft in a plane transverse to the axis of the shaft, a post extending from the plate coaxially of the shaft and a tool pivotally supported on an axis parallel to the axis of the shaft and adapted to be swung into and out of operative engagement with a piece of work supported on the plate.

Insulator. ROBERT C. SMALLEY. U. S. 1,755,971, April 22, 1930. An insulator for high-tension cable comprising in combination, an elongated cylindrical body of glazed porcelain formed with a diametrically extending cable receiving groove in the face of one end, the cylindrical body having a plurality of beads extending around the circumference of the body at its mid-point, a pair of passages proximate the groove, an axial passage at its opposite end and a radially extending recess in communication with the passage, a pliable yielding cable securing member in the passages and adapted to be looped over a cable in the groove, a bolt in the axial passage adapted to clamp the insulator to a support, a nut in the radial recess to engage the bolt, and unglazed bosses on the face of the end opposite the cable passage.

Outlet for multiple-conductor cables. ARTHUR O. AUSTIN. U. S. 1,756,233, April 29, 1930. Combination with a multiple conductor cable having an outer metallic sheath, of a body of solid dielectric material having a main passage therein for receiving the cable and having branch passages for the individual conductors of the cable, the main and branch passages being completely encircled by the material of the body, the body being tapered toward the entrance of the cable to the main passage and a metal housing tapered to conform to the surface of the body of dielectric material and disposed adjacent thereto and connected to the sheath.

Strain insulator. SAMUEL S. MATTHES. U. S. 1,756,651, April 29, 1930. An insulator comprising an insulating member, and metal fittings secured thereto by transversely disposed bolts whose axes are at right angles to each other, shims interposed between the bolts and the insulating member and of such length as to extend beyond the sides of the insulating member, each shim having a surface to conform to the surface of the insulator which it engages and means at the ends of the shims to engage the bolts.

Machine for use in manufacture of pottery. WILLIAM J. MILLER. U. S. 1,757,132, May 6, 1930. A machine of the class specified including a profile, mold carriers having molds thereon, a track adapted to support and guide a plurality of the carriers, and means for imparting movement to the carriers to bring the molds successively into alignment with the profile.

Automatic safety device for pottery machines. WILLIAM J. MILLER. U. S. 1,758,084, May 13, 1930. A pottery machine including a plurality of mold carriers, reciprocating jigger mechanism adapted to coöperate with the carriers, means for conveying the carriers horizontally over the jigger mechanism, a movably mounted cover frame, a source of power, means associated with the cover frame for controlling the source of power, the means being adapted to render the source of power inoperative

when the cover frame is raised due to abnormal operation of the mechanism and/or the conveying means.

Insulator. DAVID HENRY OSBORNE. U. S. 1,758,462, May 13, 1930. The insulator comprising a plurality of members held together by a cementitious mass of aluminate cement.

Friction tile press. FRANK B. YINGLING. U. S. 1,758,772, May 13, 1930. In a tile press the combination with a lower reciprocable die, of pedal operated means for elevating the die, a brake device for coaction with the pedal device, and a second pedal device for lowering the die.

Producing pottery. WILLIAM J. MILLER. U. S. 1,759,058, May 20, 1930. In the manufacture of pottery, the method which consists in providing a chuck and mold with communicating passages and applying subatmosphere to the mold through the passages during the jiggering operation, to evacuate air and excess moisture deposits from between the chuck and mold and the mold and charge of plastic material.

Rotary insulator. ALFRED ALSAKER. U. S. 1,759,149, May 20, 1930. A nonfreezing bearing adapted to stand exposed to the weather comprising a hollow spindle having an enlarged integral head portion at one end, an integral ball race adjacent the junction of the head and spindle, an overhanging divergent eave for the ball race, a barrel having an integral coöperating ball race disposed under the eave and balls in the races.

Insulator. ROY C. GERHARDT. U. S. 1,759,253, May 20, 1930. An insulator comprising an insulating member consisting of a body portion and axial hub extensions of polygonal formation located at the top and bottom of the body, and reversely arranged link members provided with cap portions fitting the hub extensions and slidably interlocked with the same and adapted to hold the link members against rotary movement, the link members being disposed in planes at right angles to each other.

Making pottery. J. DENGLER. Brit. 325,613, April 16, 1930. In the automatic manufacture of pottery a flat sheet of plastic material is formed by mechanism working automatically in timed relation to an intermittently-rotating table which delivers it to and presses it against the surface of a template on the table, the article thus formed being subsequently trimmed and finished, both pressing and finishing being carried out automatically and simultaneously at different points on the table so that one article is finished and delivered at each movement of the table.

Potters' setters. H. T. ROBINSON. Brit. 325,842, April 24, 1930. A setter for use in firing plates and other flat china ware is provided with an upstanding outer flange on its upper surface in order to retain the powdered flint bedding material which is placed on the upper surface of the setter. A bedder is employed to shape the upper surface of the powdered flint to accommodate the plate, etc., and also to compact the powdered flint which is applied above the plate, etc. A ring of china or porcelain is placed above a bedded plate. The setters are stacked in sets of four.

Pottery-making machines. J. DENGLER. Brit. 326,213, April 30, 1930. Jolleying-apparatus comprises an intermittently revolving table carrying a series of molds working in association with a plurality of templates having both up and down and rotary movements to bring them into and out of the working position. In the illustrated form the pair of templates are moved downwards by the cams against the action of the springs so that they enter the molds carried by the intermittently moving table.

Equipment and Apparatus

Apparatus for determination of moisture content of solids and sorption of gases and vapors by solids at elevated temperatures. WARD E. KUENTZEL. *Jour. Amer. Chem. Soc.*, **51** [12], 3560–61 (1929).—The apparatus described was used for the determina-

tion of the quantity of water vapor sorbed by a solid, granular substance from various steam-air mixtures at temperatures from 100 to 450°C. The apparatus and methods used for the determinations are fully described. The apparatus may also be used for the determination of the rate of sorption, drying, or dissociation. R.G.M.

Measurement of high temperatures. BASIL BARHAM. *Elec. Rev.*, **106** [2734], 720 (1930).—The earliest form of this metal electric thermometer was made nearly a hundred years ago, the metals used being platinum and palladium. Special electrical instruments should be used with such a couple in order that accurate results might be obtained. Platinum with an alloy of platinum and rhodium was found to be the most stable and reliable at temperatures above 1000°C. Thermocouples composed of cheaper metals which will give almost as good results are junctions of nickel and iron, nickel and copper, iron and constantan, and copper and constantan which cannot be used with temperatures above 800°C, and nickel and constantan. For furnace work in order to protect these wires from gases present they are built into insulating sleeves generally of porcelain. E.P.R.

Temperature measurement on the basis of flow technique. H. K. LEHR. *Die Messtechnik*, **6** [4], 93–95 (1930).—It is proposed to measure the gas temperature by drawing a gas stream through a system of flow resistances, connected similarly to the Wheatstone bridge of electrical technique. The measured pressure difference is a function of the temperature to be measured. This is a worthwhile substitute for the suction pyrometer. Illustrated. E.J.V.

Simple laboratory vacuum regulator. W. E. KUENTZEL. *Jour. Amer. Chem. Soc.*, **51** [11], 3347–49 (1929).—K. describes a device for controlling the degree of vacuum and thus the temperature for use where a constant temperature is desired. The apparatus is used with a vapor bath to keep the boiling liquid under a constant automatically controlled reduced pressure. R.G.M.

Vacuum meter investigations. O. M. FABER AND A. WÖMPENER. *Die Messtechnik*, **5** [7], 189–96 (1929).—This paper gives a comprehensive description of the different possibilities and ways of measuring low pressures by condensation apparatus, whereby the indicating accuracy and suitability of individual vacuum meters is hinted at. E.J.V.

Expansion measurements from 20 to 1400°C. WILLI M. COHN. *Keramos*, **9** [7], 215–18 (1930).—The apparatus consists of a tube furnace with optical comparators for following the expansion behavior of ceramic materials. A second method designated as the comparison method is also described. In the case of the second method the material under investigation is clamped on a fused quartz mounting and the differential expansion of the fused quartz and material being tested is determined. F.P.H.

Viscosimeter for liquids. WALTER BÜCHE. *Die Messtechnik*, **5** [8], 220–21 (1929).—A new viscosimeter for liquids is described which has an accuracy great enough for commercial practice and can be placed on the market very cheaply. It consists of a hollow body which is placed in the liquid and has an appropriate capillary in it through which the liquid ascends into the body. The sinking speed, measured by two marks on the body, gives a measure for the kinematic viscosity. Illustrated. E.J.V.

Instruments and apparatus. Preliminary draft of Part 17. Determination of the viscosity of liquids. ANON. *Mech. Eng.*, **52** [3], 233–34 (1930).—A general discussion of the term "viscosity" is given. The available instruments, procedure to be followed, precautions in taking readings, and types of viscometers are discussed briefly. H.W.A.

Photoelectric cell. EDITORIAL. *Mech. Eng.*, **52** [5], 569 (1930).—The photoelectric cell is a development of the original idea embodied in the selenium cell, a re-

sponse to variations in light. Unlike the selenium cell, it can be made extremely sensitive. Its applications are of various kinds. It has been used to detect fumes in tunnels, as a method of train control, as a burglar alarm, etc. There are many possibilities for its application to other problems. H.W.A.

Dewatering clay suspensions by electrophoresis. ANON. *Queensland Govt. Mining Jour.*, **30** [8], 397 (1929); for abstract see *Ceram. Abs.*, **9** [4], 297 (1930). E.P.R.

Hardinge constant weight feeder. ANON. *Brick Clay Rec.*, **76** [9], 599 (1930).—A regulating feeder which eliminates variations in feed due to changes in size of material, moisture content, and specific gravity has been developed by the Hardinge Co. This feeder regulates by weight rather than volume. It automatically maintains the weight constant, no matter how conditions change. Details of construction and operation are explained. Illustrated. E.J.V.

Monotron hardness indicator. ANON. *Engineering*, **129** [3345], 252 (1930).—The monotron is used for determining the hardness of metals, minerals, vitreous materials, and of organic substances such as rubber and wood. For standard hardness tests the load required to cause a small spherical diamond to penetrate the material to a given depth is taken as a measure of the hardness. By means of a chart the results obtained may be easily correlated with the Brinell and scleroscope tests. A.A.

Recent improvements in continuous system of grinding. G. F. METZ. *Ceram. Ind.*, **14** [5], 558–60 (1930).—Early applications of the continuous mills to the grinding of ceramic materials included conical mills and tube mills in open circuit. These mills were later operated in conjunction with vibrating screens and air classifiers which improved operations materially. By increasing the feed to the mill, and sending a product which was only partially finished to the screen or air classifier, and by returning the tailings to the feed end of the mill, capacities were increased, and savings made. Recently there is a tendency to install an air classifier unit with the mill. An exhaust fan is used to remove the semipulverized material through a classifier, automatically returning the oversize to the mill and removing the fines as soon as they are formed. The product is more uniform than that secured with mills operating in conjunction with outside classifiers. With the latter type, the fines formed in the first few feet of the mill must traverse the entire length of the mill before being removed, thus cushioning the action of the pebbles and preventing them from effectively reducing the granular material. Generally speaking, these systems have found applications in the dry grinding of such ceramic materials as feldspar, silica and sand, enamel frit, barium oxide, clay, and refractories used in the manufacture of refractory cements. By use of the reverse current system of classification, the layout has been simplified by eliminating such auxiliaries as elevators and conveyers, with their drives. By placing the classifiers and cyclone collectors on the suction side of the exhaust fan, wear and tear on the latter have been found reduced to the minimum, as the exhaust fan handles only clean air. F.P.H.

Closed circuit grinding offers advantages with wet or dry reduction. STURTEVANT ENGINEERS, INC. *Brick Clay Rec.*, **76** [8], 526–30 (1930).—Open-circuit grinding, sometimes known as one-passage grinding, requires the pulverizer to finish all the material fed to it in one passage. This is the principle used in old millstones, tube mills, roller, and ball mills, whether using internal screens or not. All these mills are required not only to grind but also to size within the mill, discharging only when the material is reduced to the finished state of subdivision. Such a method necessitates that the pulverizer grind to a finish the entire amount fed to it. The amount fed must exactly equal the amount discharged, because if fed too fast the product would be too coarse and the mill would become "plugged." If underfed, the output would be finer than

necessary (overground). Under such circumstances, when estimating the feed rate, the physical characteristics of the material being ground, its size, hardness, toughness, moisture content, etc., must be considered. Closed-circuit grinding may be defined as that method of reduction in which the pulverizer is operated in closed-circuit (in connection) with a classifier (wet, dry (air) or screen), in which case the mill is not required to finish to the desired fineness, in one passage through, all of the material fed to it. The responsibility for sizing rests entirely with the classifier, the only duty of the mill being that of pulverizing. The total discharge from the mill (coarse and fine) passes through the classifier which selects that portion which is of the required fineness. The rejection, or "circulating load," is returned to the mill with the fresh feed for further reduction. The inefficiency of the open-circuit grinding is illustrated by data and a sketch of the system. The advantages gained in the closed-circuit grinding are (1) large increase in output, (2) accuracy and uniformity of product, (3) fineness of product (4) complete control of output, and (5) labor saving; as the mill and separator are automatic. Four methods of using a preliminary grinder in connection with closed-circuit grinding are outlined. Illustrated. E.J.V.

Fine grinding executes trend toward quality. F. S. WINDOLF, S. E. BERRY, AND JAMES P. MARTIN. *Brick Clay Rec.*, **76** [8], 515–18 (1930).—The unmistakable trend toward a higher quality product in every branch of the heavy clay products industry is seen in the increased care which is given to the preparation of raw materials. One of the most noticeable improvements in this respect is in the fine grinding of surface clays, usually used in the manufacture of common brick. One of the benefits derived from fine grinding is the elimination of lime pebbles which are found in most surface clays. The most successful installation for this purpose has been found to consist of a set of rolls designed to throw out the larger pebbles and an additional set of rolls in which the smaller pebbles are reduced to a very fine powder which will mix with the clay so thoroughly that it will do no harm. Drier and kiln loss is often due to improper grinding of raw materials. Another benefit in fine grinding not to be overlooked is the improved appearance of the ware. Conical rolls are used as stone eliminating rolls to relieve the fine grinding rolls of the burden of handling the large foreign particles in the clay. The fine grinding rolls must have hard shells, must run concentric, so that the rolls can be set up close to each other, preferably one-sixteenth inch or less, and there must be provision for grinding the rolls true in place in the machine. Illustrated. E.J.V.

Coal pulverizer built with magnetic separator. ANON. *Pit and Quarry*, **20** [1], 91 (1930).—A new type of coal pulverizer has just been designed by Aubrey J. Grindle of the Pulverized Fuel Equipment Co. This is to be known as the type B Purfeco unit. E.P.R.

Characteristics of various types of primary and secondary crushers. G. B. MASSEY. *Pit and Quarry*, **19** [5], 59–62 (1930).—Several types of crushers are in use in quarries today. They are known as the gyratory crushers, jaw crushers, single-roll and the double-roll crushers. These are described and illustrated. F.P.H.

Apparatus for cutting brick and similar products. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 244, pp. 12–15B (1930); for abstract see *Ceram. Abs.*, **9** [6], 450 (1930). A.J.M.

Impact mills for grinding fire clay. O. M. TUPPER, JR. *Mining and Met.*, **11** [281], 266–67 (1930).—Further discussion of the article on this subject by O. M. Tupper, Jr., that was presented at the October, 1929, San Francisco Meeting of the A.I.M.M.E. See also *Ceram. Abs.*, **8** [12], 904 (1929). F.P.H.

Eliminating dust nuisance in cement plants. SCHIRM. *Gesundheit Ingenieur*, **53**, 8 (1930); *Rock Prod.*, **33** [8], 90 (1930).—S. describes the various methods employed

in eliminating dust in cement plants, particularly rotary kiln operations. The advantages and disadvantages of each method are pointed out. W.W.M.

Use of wire rope by steam-electric generating plants. J. R. McCAUSLAND. *Mech. Eng.*, **52** [5], 529–32 (1930).—The factors affecting life of wire rope are discussed under the following headings: (1) materials, (2) manufacture, (3) installation, (4) operation, (5) maintenance, (6) inspection, and (7) the human element in regard to the use and care of rope. Eleven common sources of friction are (1) lack of proper lubrication, (2) restricted fleet of sheaves adjacent to drums, (3) smooth-surfaced drums, (4) misalignment of sheaves, (5) improper shape of groove profiles, (6) worn or scored groove profiles, (7) stationary iron rope guides, (8) bucket sheaves and rope guides, (9) general wear on fraction of whole rope, (10) scrubbing of adjacent ropes, and (11) improper splicing. Each of these sources of friction is discussed. Bending, tensile, and shearing stresses are augmented respectively by (1) small sheave and drum diameter and reverse bends, (2) rapid acceleration and deceleration of load, and (3) improper reeving of rope. H.W.A.

Testing laboratories for refractories. L. LITINSKY. *Feuerfest*, **6** [1], 1–11, 17–25, 33–39, 49–57 (1930).—Description of various testing machines seen in laboratories in Europe. L.T.B.

New process of drying. W. MAYBAUM. *Tonind.-Ztg.*, **54** [24], 409–10 (1930).—The process is based on the property of air to absorb more humidity when it is hot than when it is cold. One method of drying is by alternate currents in which a damp warm air stream alternates with a hot air stream The second type of drying is by a continuous uniform current of warm air controlled by ventilators. The velocity of air in such installations must be low and the motion of the air must be constant and uniform. M. constructed a drying installation which combines both methods of drying outlined above. There are two adjacent chambers in one of which warm air circulates and in the other hot air. The hot air from the first chamber travels into the second chamber, then after a certain length of time the movement is reversed and the air of the second chamber passes into the first. In this way a continuous movement of air is maintained at a temperature of 95 to 100°. In this drying installation with 33,000 cu. m. of air per hour, and at a temperature of 92°, 20,000 brick having a moisture content of 1100 g. each, were dried in 25 hrs. and 22,000 kg. of water evaporated. M.V.K.

Considerations on the drying of brick and tile. ANTOINE RAYMOND. *Rev. mat. constr. trav. pub.*, No. 244, pp. 1–2B (1930). A.J.M.

Intraplant movement of materials. G. L. MONTGOMERY. *Chem. Met. Eng.*, **37** [4], 204–27 (1930).—Four general classes of equipment available for handling solid materials are (1) conveyers, (2) overhead equipment, (3) trucks and tractors, and (4) industrial railways. Types of conveyers classified in accordance with the direction of motion for which they are suited are (1) horizontal, (2) vertical, and (3) combined vertical and horizontal. Each type is illustrated with drawings and photographs. Overhead equipment is of two classes, (1) lifting only and (2) lifting and transporting. The types under each are defined, and illustrated with drawings. Trucks and tractors are of two general types, (1) hand operated and (2) power operated. An outline on the selection of equipment indicates what study must be made of the work to be done. Tables are given classifying the solution of handling problems, where large, medium, and small quantities of material are considered. A series of tables shows speeds, capacities, sizes of materials handled, and general information assisting in the selection of the following kinds of conveyers: belt, bucket, chain, chain trolley, apron, pan, slat, platform chain and tray, bucket carriers, flight and scraper, drag chain, screw, gravity roller, and pneumatic. Data and list prices are also given for all of these types. G.R.S.

Flint and feldspar plant employs pumping of dry solids. H. P. MARGERUM. *Chem. Met. Eng.*, **37** [4], 237–38 (1930).—Ground feldspar is difficult to handle in many mechanical conveying systems because it is quite abrasive and tends to absorb moisture from the atmosphere and form a cake in chutes or bridge over in hoppers. An outline is given of the method used in crushing, screening, and pumping feldspar into storage bins. A flow chart of flint and feldspar grinding shows the material handling equipment. Once feldspar is aerated it behaves like a liquid and is forced by a pump through a $2^1/_2$ in. line to six elevated concrete storage bins. The material flows directly from the line into the bin, practically without dust and spreads like a liquid. Fuller-Kinyon pumps are employed. G.R.S.

New laboratory air separating unit. ANON. *Brick Clay Rec.*, **76** [9], 599 (1930).—The Federal air separating unit embraces centrifugal separator and Federal closed circuit collector, together with fan and universal motor operated from light socket. The separator consists of head section, hopper, and cone section, with tangential air inlet built into the upper part of head section and tangential mesh valve air inlet applied to the cylindrical part of the cone section. The Federal closed circuit collector is assembled with cylindrical section mounted on long taper cone section. The cylindrical part is equipped with a hopper having a drum extension which divides the cylinder into upper and lower chambers. The principle of operation of the unit is given in detail. Illustrated. E.J.V.

Applications of air separation are numerous in nonmetallic mineral plants. RUBERT M. GAY. *Pit and Quarry*, **19** [13], 76–79 (1930); for abstract see *Ceram. Abs.*, **9** [5], 364 (1930). E.P.R.

Pneumatic conveying system installed for handling bulk lime. H. J. LEVINE. *Pit and Quarry*, **20** [1], 74–75 (1930).—L. points out how his company overcame difficulties of lime handling by adopting the pneumatic conveying system and sums up the advantages of the method. E.P.R.

Increasing efficiency of transmission belts. D. GUISEPPE MILANI. *Corriere ceram.*, **10** [10], 377–79 (1929).—The following observations on the more efficient use of leather belts were taken by M. from the publication *Direzioni dei reparti* of M. F. W. Taylor: (1) Transmission belts which are narrow and thick wear better than wide and thin belts; (2) pulley faces should be 25% wider than the belt; (3) best distance between the axes is from 6 to 7.5 m.; (4) tension pulley should be provided; (5) a "double" belt can be used on a 300 mm. pulley; a "triple" belt on 500 mm., or more in diameter; a "quadruple" belt on more than 760 mm.; (7) inspection should be made at regular intervals; (8) most economical weight for double belt is between 11.6 to 13 kg. per cm. of width; or 14 to 15.75 kg. per sq. cm. of section. Other factors influencing the durability of belts besides the weight are the manner of joining, polishing, and greasing, and the velocity (which should be between 1220 and 1380 m. the first minute for maximum efficiency). M.V.K.

Modern ammonia-soda plants capitalize on economies of mechanical handling. L. C. HUGHES. *Chem. Met. Eng.*, **37** [4], 232–34 (1930).—Because of the sizable tonnages involved and high labor cost the handling problems especially in the lime burning have been carefully worked out. A flow sheet of the process indicates the difficulties to be met. Belt conveyers bring limestone from the hold of the boat, delivering it to a boom conveyer which can swing to any point on shore within a radius of 50 ft. From 8000 to 10,000 T. can be unloaded in 6 to 10 hrs. A description is given of screening, storage, weighing, mixing with coke, and charging into kilns. Kiln capacities are 400 T. or more per day. G.R.S.

Arrangement for transporting wet clay. D. S. *Rev. mat. constr. trav. pub.*, No. 244, pp. 15–16B (1930). A.J.M.

Handling raw materials by pneumatic conveyers. ANON. *Ceram. Ind.*, **14** [5], 541–46 (1930).—Pneumatic conveying is possible either by use of pressure or suction. When the pressure nozzle is immersed in the material, or the material is fed to the injector, the compressed air carries it along the desired course. There are a number of low-pressure conveying systems consisting of a centrifugal fan, piping, and a cyclone collector. These systems are inexpensive and function successfully for low tonnages of such materials as sawdust, shavings, and fibrous materials. Closely related is the pumping of dry pulverized materials, such as cement, pulverized feldspar, gypsum, clay soda ash, lime, etc., through pipe lines. The system depends upon the peculiar characteristic of most dry pulverized materials to become aerated and fluent when mixed with air. In this condition the materials can be forced by mechanical pressure over comparatively long distances, systems up to three thousand feet in length being used. For general classification suction systems operate at a negative pressure up to one inch of mercury, medium vacuum from 2 to 8 in., and high vacuum from 12 to 20 in. Vacuum systems are designed to handle dusty materials which require a receiver and filter, and those designed to handle materials not carrying dust such as grain, seeds, etc., which use the receiver without the filter. The first type is of most interest to ceramic manufacturers. Dusty material is blown into a cyclone collector where about 90% of the solids are precipitated. To prevent wastage of the 10% of fine material a second cyclone and set of filters may be provided. F.P.H.

Diesel engines, their present and possible applications in the pit and quarry industries. I. J. O. DURKEE. *Pit and Quarry*, **18** [12], 67–77 (1929).—A short historical sketch of the development of oil engines and descriptions of different types which are adapted to the pit and quarry industries is given. E.P.R.

Diesel engine. R. SCHWARTZ. *Tonind.-Ztg.*, **54** [28], 479–80 (1930).—S. discusses the use of the Diesel engine in ceramic plants and points out its advantages in comparison with steam engines. M.V.K.

Self-unloading sand boat on Lake Constance. ANON. *Technique Moderne*, **21**, 701–702 (1929); *Rev. Brown-Boveri*, Aug., 1929; *Pit and Quarry*, **19** [13], 68 (1930).—A new type of vessel equipped for self-unloading of its cargoes has been in service on Lake Constance, Switzerland. The self-unloading equipment, permitting one man to unload 53 cu. yd. per hour, consists of two screw conveyers in the bottom of the hull discharging to a chain-bucket elevator amidships, which in turn discharges by means of a spout from the head of the elevator to belt conveyer. E.P.R.

Alton Brick Co.'s quick delivery service. ANON. *Brick Clay Rec.*, **76** [9], 578–79 (1930).—The Alton (Ill.) Brick Co., supplying face brick and other clay products to Alton and to the metropolitan area about St. Louis, maintains three plants, none of which is more than 20 miles from another or from the central distributing yard. Fontaine demountable bodies are being put in as standard trucking equipment, permitting one truck to do the work of two. The speedy delivery made possible by the arrangements in effect is a point in customers' service which cannot be overlooked. E.J.V.

Loading bulk gypsum into box cars. ANON. *Pit and Quarry*, **19** [13], 92–93 (1930).—One method of loading bulk material into box cars is with a centrifugal loading machine. This high-speed centrifugal machine will load a car in about 20 minutes. The machine weighs but 730 lbs. and operates on a 3-H.P. motor. E.P.R.

Wheelbarrow in ceramics. H. M. KRANER. *Chem. Met. Eng.*, **37** [4], 235–37 (1930).—Handling raw materials in the several branches of the ceramic industry presents two definite aspects. (1) In heavy clay products the volumes of material consumed are large and materials are of a rather low grade. (2) In the whiteware industry, high grade clays, flint, and feldspar are used in large quantities. The methods used in handling them must be such that their purity is maintained. Descriptions are

given of methods employed in various plants, indicating the amounts of raw materials handled. G.R.S.

Mechanical handling. ANON. *Chem. Met. Eng.*, **37** [4], 202–203 (1930).—Importance of materials handling is shown by the fact that handling within the plant accounts for 22% of industry's labor payroll, and that is equal to 80% of the amount going into product transportation outside the plant. G.R.S.

What mechanical handling offers to the chemical engineer. ANON. *Chem. Met. Eng.*, **37** [4], 201 (1930).—An outline of the subjects treated in this issue amounting almost to a handbook. G.R.S.

Dicol heavy oil burner. ANON. *Engineering*, **129** [3346], 300 (1930). A.A.

Chromium plating. ANON. *Popular Sci.*, **116** [5], 51 (1930).—The operations involved are "stripping" or cleaning, by sandblasting or acid treatment of the article; successive nickel-plating, copper-plating, replating with nickel, and chromium plating. After each plating the article is polished. The object of the platings with copper and nickel is to secure a smooth, even coat of chromium. Illustrated. E.J.V.

New type microscope has novel feature. ANON. *Popular Sci.*, **116** [5], 34 (1930); see also *Ceram. Abs.*, 9 [5], 366 (1930). E.J.V.

Type of brick machine oil influences power consumption. ANON. *Brick Clay Rec.*, **76** [9], 572 (1930).—Few clay products manufacturers give very serious attention to the matter of lubricating auger machine dies. There has been little research on this subject and most machinery manufacturers are content to recommend the use of a cheap lubricating oil or even crank case drainings where oil lubricated dies are used. An investigation of this subject made by the Royalton Face Brick Co., Middletown, Pa., in coöperation with lubrication experts showed some startling differences in power consumption with different types of oils. These tests demonstrated that the subject is well worth the time of any manufacturer to investigate. The tests showed that the grade and density of the oil has a material influence on the power consumption and demonstrated the inadvisability of using an oil of low density. There is also reason to believe that companies now using water or steam for lubrication may find this a costly practice from the standpoint of power consumption. E.J.V.

Carbon in coal. R. E. BREWER AND E. P. HARDING. *Colliery Guardian*, **140** [3602], 142 (1930).—A modification of Parr's total carbon determination in coal is described. Parr proposed a gas volumetric method for determining carbon from the residue obtained by fusing the coal sample with sodium peroxide and potassium chlorate. The residue consists largely of sodium carbonate and sodium peroxide. This is dissolved in water, treated with concentrated hydrochloric acid, and the evolved carbon dioxide is measured under known conditions of temperature and pressure. The total carbon apparatus designed by Parr has been changed in several minor respects and used under slightly different conditions. These changes have resulted in an easier control of the temperature, have eliminated the need of compressed air, and have made possible a higher accuracy of results due to a better control of the experimental conditions. E.J.V.

Metals for brass pickling containers. ANON. *Iron Age*, **125** [13], 917 (1930).—In an address before the A.S.M.E., Dayton, Ohio, Feb., 1930, P. D. Schenck stated that high silicon iron (Duriron) is the only material which will stand a combination of free sulphuric acid and weak copper sulphate. If the concentration of copper sulphate is high, 18–8 Cr-Ni alloys will do but they do not stand a high per cent of free sulphuric acid. E.C.C.

Revision and addenda to the Boiler Construction Code. ANON. *Mech. Eng.*, **52** [5], 557–65 (1930).—The Boiler Code Committee of the A.S.M.E. published a number of suggested revisions to the Code for criticism and comment. H.W.A.

Official changes in the active list of permissible explosives and blasting devices for March, 1930. ANON. Bur. Mines, *Rept. of Invest.*, No. 2992 (March, 1930).—Supplements complete active list of permissible explosives published in July, 1929, as serial No. 2947, and subsequent lists of changes designated as serials No. 2953, 2958, 2962, 2972, and 2988. R.A.H.

Recovery of kiln dust in Belgian cement plant. ANON. *Annales de Mines de Belgique*, Vol. 29 (1928); *Pit and Quarry*, **20** [1], 86 (1930).—Technical data on the operation of an electrical precipitation system for removing dust from cement kiln gases at the Chercq cement plant of the Société Louis Delwart et Fils, Tournai, Belgium, are given. E.P.R.

Wire saw 1400 ft. in length used in Ozarks. ANON. *Pit and Quarry*, **20** [3], 35 (1930).—A quarter-inch, three-stranded steel wire, 1400 ft. long, driven by an automobile engine, is sawing huge slabs of marble from a hillside in the Ozark region of Arkansas. Wire sawing already has proved its value in slate quarrying in Pa. E.P.R.

BOOK AND BULLETINS

Principles of Electroplating and Electroforming. WILLIAM BLUM AND GEORGE B. HOGABOOM. 2nd ed., 424 pp. McGraw-Hill Book Co., Inc., New York. Price $4.50. Reviewed in *Can. Chem. Met.*, **14** [4], 58 (1930).—A number of new chapters appear on such subjects as chromium plating. The book is a text on the principles of the chemistry involved. Electrochemistry is dealt with in a way which a student plater should be able to follow, but the main portion of the work deals with the actual deposition of metals and alloys. One chapter is devoted to experimentation and offers directions and general suggestions which would be helpful in a works laboratory when a plater wished to try out variations of any kind. E.J.V.

Classification and tabling of difficult ores with particular attention to fluorspar. W. H. COGHILL. Bur. Mines, *Tech. Paper*, No. 456; 40 pp. (1929).—The jiggering and tabling of Ill. and Ky. fluorspar ores offer a good basis for study in ore dressing. The gangue is calcite, quartz, and quartzite. The present paper shows the following points: (1) An ore containing heavy mineral that has been unlocked by grinding may not need classification. (2) It is desirable to apply classification so that the range of sizes containing locked grains will be more closely classified than the part of the ore that has been liberated by crushing. (3) Tables are too big when the classifier is overtaxed to load them, and the laws of classification are thereby violated. (4) The screen analysis of the feed and also the relative settling rates of the disseminated grains must be taken into account before the classifier can be scientifically adjusted. (5) The literature places too much emphasis on hindered settling ratios. (6) Hindered settling does not have much advantage over free settling when the minerals or the disseminated grains are nearly as light as the gangue. Such an ore is in most need of classification. (7) The proper rate of flow of spigots may be scientifically determined. (8) The nature of the material in the first spigot when the feed is prepared by a limiting screen is entirely different from that when the feed comes to the classifier from overflow devices. (9) A fluorspar ore is excellent for study. The results of classification are given. (10) The force diagram may be used to determine mean mesh. (11) The use of average diameters which takes into account the dimensions of sieve openings is not desirable, and it is a mistake to regard as a final criterion the ratio of the average diameters of the light mineral grains to that of the heavy mineral grains in a classified product. If the classification is good, the settling ratios will, however, indicate the amenability of the ore to table concentration. (12) The degree of sizing, not the hindered-settled ratio of the respective specific-gravity increments, determines the efficiency of the classifier. Heavy liquids are used to obtain the specific-gravity increments.

(13) The efficiency number (degree of sizing) may be determined. The efficiency number enables scientific adjustment and comparison of classifiers. (14) A classifier tends to segregate the heavy minerals in the first spigots and the light minerals in the last. (15) The feed to a classifier is generally of such a nature that it gives first spigots that are very rich, intermediate ones of the same tenor as the feed, and the last ones of low grade. The best ultimate results will be obtained when the low-grade products come nearest to the zero range of sizes. It is therefore desirable to use the finest possible limiting screen at the head of the classifier. Screens should be used to size the material that is coarser than the limiting screen ahead of the classifier. (16) Screen sizing is technically an efficient method of preparing a table feed. (17) A one-way classifier will concentrate middlings. (18) Classified fluorspar with a mean diameter as fine as 65-mesh may be concentrated on a table. (19) Commercial classification of ores other than fluorspar gives desirable sizing. Price 15¢. R.A.H.

Centrifugal concentration. H. A. DOERNER. Bur. Mines, *Tech. Paper*, No. 457, 39 pp. (1929).—This paper deals with an investigation of centrifugal concentration, especially its application to the treatment of the slime portion of tailings from mills that use gravity-concentration methods. The purpose of the present paper is to increase interest in centrifugal concentration by a discussion of the theoretical principles involved, an analysis of various machines that have been invented, and a description of the construction and operation of experimental machines. The report discusses the relation between gravity and centrifugal concentration; fundamental requirements for concentration; calculation of centrifugal force and pressure, and the following centrifugal concentrators: riffle with hydraulic discharge, free settling classifier, hindered settling classifier, jig with hutch discharge, hydraulic riffle, and centrifugal bubble. Description of plant and laboratory tests is included. Price 10¢. R.A.H.

G. E. super-synchronous motors for large grinding and pulverizing mills. ANON. 4 pp., 5 illus. *Pit and Quarry*, **19** [5], 100 (1930).—A catalog of the General Electric Co. describes and illustrates various applications of synchronous motors driving tube, finish-grinding, and ball mills. E.P.R.

Complete reference data on double-crimped wire-cloth and woven screens. ANON. Reviewed in *Pit and Quarry*, **19** [5], 100 (1930).—The Ludlow-Saylor Wire Co. has issued a booklet illustrating the use of wire cloth in filters, separators, screens, mills, etc. E.P.R.

PATENT

Regulating lateral movement of longitudinal sieves. WALTER BRECHT AND ERICH SCHAUN. U. S. 1,755,202, April 22, 1930. In a machine of the character set forth, consisting of a longitudinal web carrying sieve arranged to have lateral shifting from one position to another and a control roller controlling the shifting of the same, a counterbalanced vertically swingable strike plate, means for directing a jet of water upon the strike plate whereby to operate the same, positioned to insure interception of the jet of water by the sieve when the latter is in one position of movement, and means controlled by the operation of the strike plate controlling the operation of the control roller.

Kilns, Furnaces, Fuels, and Combustion

Brick kiln for drying and firing. JULIUS KEEDERS. *Tonind.-Ztg.*, **54** [13], 209 (1930).—This continuous kiln is so constructed that the heat from those chambers which have finished firing is made use of for drying the ware. The brick are brought into the kiln immediately after pressing and remain from 30 to 36 hrs. without being fired and without air currents. By radiation of the kiln walls the brick are slightly

warmed and even hardened. After this they are fired for 24 to 28 hrs. Such a kiln can be heated by gas or scattered firing depending on the ware. The kiln is described. M.V.K.

Coulhon annular kiln. F. BOTERMANS. *Kley*, **21** [8], 92–96; *Tonind.-Ztg.*, **54** [21], 367 (1930).—B. describes a Coulhon annular kiln with grates. The operation of the kiln is described. The consumption of coal is 40 kg. of coal for 1000 kg. of ware fired at 900°C, 65 kg. at 1250°, and 95 kg. at 1460°C all with a charge of 950 kg./cu. m. Fifteen such kilns are in operation and can be fired with coal or wood. M.V.K.

Materials for dressing kiln surfaces. ANON. *Tonind.-Ztg.*, **54** [22], 379 (1930).—Two compositions of dressing materials are given which were used with good results: 10 parts of sodium silicates, 20 parts of rock salt, 10 soda ash, 15 fluorspar, or 5 water glass, 10 finely sifted kiln ashes, and 130 raw clay. The walls of the kiln are covered with a slip. At 600° this composition has already fired into the brick and joints; it glazes at higher temperatures. The second composition is for temperatures of 900 to 1000°. For high temperatures, refractory clays must be used instead of ordinary clays and grog powder instead of ashes. At temperatures higher then 1100° sodium is not used and at still higher temperatures the salt is also left out. The composition is as follows: for 900 to 1000° (Seger cone 010a to 05a): 10 parts of sodium, 5 dry water glass, 5 liquid water glass, 20 rock salt, 5 glass powder, 100 clay and depending on plasticity, 10 to 30 finely-ground brick powder. The salt is dissolved in boiling water to which the sodium and water glass are added. The covering must be done when the kiln is in operation. It is well sometimes to add 20 to 30 parts of blast-furnace slag especially at temperatures of 950 to 1100°. M.V.K.

Use of air in continuous kilns. ANON. *Brit. Clayworker*, **39** [456], 10–12 (1930).—Air is required in continuous kilns: (1) to carry moisture from the brick; (2) to warm the brick prior to their being preheated so as to prevent scum or kiln white; (3) to support the combustion of the fuel in the chambers being fired, and also in the preheating chambers; (4) to oxidize any iron compounds present to produce a good red color; (5) to burn away any carbonaceous matter present in the goods, and so prevent the formation of cores or black heart; and (6) to cool the fired goods, so they may be handled conveniently. The volume of air, as well as its temperature, are important factors in the efficient working of a kiln and almost equally essential is the length of time the air is in contact with the ware or fuel. In order to make the best use of the air the following precautions should be observed: (1) The ware should be as dry as possible before entering the kiln and must be properly placed so as to not baffle the air and gases unduly. (2) Every effort should be made to keep the kiln working regularly. (3) The fuel should be added regularly and as often as possible. (4) Some means should be used to ascertain the temperature and draft of the kiln and to keep these as constant as possible. (5) A draft regulator is desirable to ensure a constant volume of air and gases passing through the kiln. (7) The preheating and cooling zones should be of ample length to ensure all the gases being heated to the requisite temperature. (8) An unnecessarily large supply of air should be avoided but care should be taken to see that ample is supplied. R.A.H.

Lighting continuous-fire kilns. J. WELTER. *Rev. mat. constr. trav. pub.*, No. 244, pp. 3–5B (1930); see also *Ceram. Abs.*, **9** [6], 457 (1930). A.J.M.

Removal of ash in furnaces burning powdered coal. ANON. *Colliery Guardian*, **140** [3608], 720 (1930).—Three coals having fluid temperatures for the average ash of about 2400, 2600, and 2800°F were burned. Some of the preliminary findings are as follows: A selective separation occurred which increased the percentage of fluxes in the slag, compared with that in the ash of the coal. The percentage increase was greater as the percentage of fluxes in the original ash was lower. The softening tem-

peratures of the slags were lower than those of the original ash, but the fluid temperatures were not changed to as great an amount. The lowering of the fusion temperatures increased as the fusion temperatures of the original ash were higher. E.J.V.

Tunnel kiln cars. ANON. *Refrac. Jour.*, **5** [55], 259 (1930).—It has been found that the maximum temperature at the axles of the tunnel kiln car is between 271 to 320°C, and the oil proving most promising is described as "650 S.R. stock" having a flash point of 573°F and fire point of 640°F 0.9168 SP. The mixture given is oil 500 g., graphite "super-air floated" 176.5 g. The lubrication was carried out by a hose attached to a tank under 15 lb. pressure and the cars were able to go through the tunnel three times without further lubrication. E.P.R.

Chimneys and draft. W. F. SCHAPHORST. *Pit and Quarry*, **19** [13], 71 (1930).—A chart useful for determining the number of pounds of coal that may be burned per hour on a given grate, knowing the area of the chimney in sq. ft. and the height of the chimney above the grate in feet, is given. The range of the chart is great enough to take care of any chimney that has ever been built, from 10 to 1000 ft. in height and in area from 2 sq. ft. to 2000 sq. ft. It is based on the formula: $A = \frac{F}{21.8\sqrt{H}}$, where A = the cross-sectional area of the chimney in sq. ft., F = number of pounds of coal burned per hour, H = height of chimney above the grates, in ft. E.P.R.

Utilization of waste heat from brick furnaces. JOSEF PÖSSNER. *Stavivo*, p. 238 (1929).—Theoretically the annular furnace should need only the heat required for compensating the losses by radiation occurring, *i.e.*, about 450,000 calories per 1000 brick 29 by 12 by 6.5 m. in size. Actually the heat supply must be greater as there exists other losses: (1) the chimney losses of about 300,000 calories; (2) 30,000 calories are lost in the goods discharged from the furnace and 190,000 calories are lost in the air. These data are the average values of a series of tests carried out to state the heat consumption of Hofmann's and Bührer's annular furnaces per 1000 brick. To these losses must be added the heat required for evaporating and expelling the bound water, *i.e.*, about 300,000 calories, and for decomposing $CaCO_3$, about 30,000 calories per 1000 brick, altogether about 1,300,000 calories or the calorific value of 200 kilos of coal of 6500 calories. If it is presumed that for drying 1000 brick an amount of heat of 1,500,000 cals. is required (there are, however, furnaces needing only 1,000,000 cals.; theoretically 600,000 calories are necessary), it is obvious that by the flue gases, before leaving the chimney, $\frac{1,500,000}{300,000}$ brick can be dried, *i.e.*, 200 brick. If only 80% of the heat lost by radiation through the walls could be recuperated this would be sufficient for drying 240 brick. P. designed a drier which is heated by waste gases and dries perfectly 600 brick per 1000 brick manufactured. See also *Ceram. Abs.*, **9** [5], 369 (1930). R.B.

Seger cone diagram as a basis for firing and the test of fine and coarse ceramic products. FRIEDRICH DETTMER. *Sprechsaal*, **63** [10], 173–76; [11], 189–92; [12], 207–10 (1930).—From observations of curves of heat transmission, change of fluidity, processes of diffusion, etc., which take place during the firing of a Seger cone or in firing a ceramic paste, analogous curves are found even though complete identity does not exist. From this fact and with the help of thermodynamics, far-reaching conclusions from a Seger cone diagram can be made except in certain cases as exothermic reactions, and glazes containing boric acid. This is a Seger cone time diagram. If curves of shrinkage, vitrification, fusion, etc., are diagrammed, exact and clear directions for firing and testing ceramic products are obtained. The natural limits of the Seger cone hitherto existing are explained and the demand for further series of cones and change of the present ones is raised. M.V.K.

Calorimetric investigations. A. SCHÜKAREW. *Die Messtechnik*, **5** [3], 63–65 (1929).—After a discussion of the difficulty of determining the water equivalent of the calorimeter bomb, a comparison is made of various methods of making this determination. A new method is worked out which merits adoption on account of its accuracy and simplicity. Numerical data to indicate the merits of this method, in which benzoic acid is used, are included. Illustrated. E.J.V.

Cost of air heating. WILLIAM A. BUTLER. *Clay-Worker*, **93** [4], 288 (1930).—A close-up of present-day industrial furnaces discloses that the economy of a furnace corresponds with the cost of heating the combustion air. In line with this conclusion in everyday practice, it is known that it is impossible to light a fire without first heating the combustion air. It is known from experience as well as theoretically that the preheated air method is by far the most economical, *i.e.*, 200 lbs. bituminous coal fires 1000 6-lb. brick in the Hoffman kiln, while more than twice this amount of coal is required to fire 1000 brick in the downdraft kiln. The difference in the amount of coal represents the cost of air heating in the downdraft kiln with cold air for combustion. Two methods of firing with pulverized coal are discussed, one in which the air is preheated and the other in which it is under pressure and requires extra coal to heat it. E.J.V.

Fuel requirement for ceramic practice. C. W. PARMELEE AND R. K. HURSH. *Brick Clay Rec.*, **76** [9], 584–85 (1930).—In the production of ware when color is important and in connection with glazed products it is desirable to use coal with a minimum sulphur content, preferably not exceeding 1%. The heating value of a coal deserves the same consideration in ceramic uses as in other applications. Coals of high quality in this respect are generally more economical than those of lower grade because of the better fuel efficiency obtained. Long-flame coals are preferable for firing clay products, especially in periodic kilns where the distance of gas travel is relatively great. Short flame coals tend to develop excessive firebox temperatures but do not give as good heat distribution within the ware. The highly volatile coals require more attention and care in firing than do the short-flame coals. In the firing of car tunnel kilns with coal it is likely that a lower volatile content and shorter flame would be desirable, since the distance of flame travel and the volume of combustion space is much less than in periodic kilns. While coals of high volatile content are generally desirable for kiln firing, the caking coals are not adaptable. The quality as well as the quantity of ash in the coal is to be considered. Coals differ greatly in the fusibility of the ash, some fusing at relatively low temperatures and producing clinkers, while others are refractory and do not clinker. The slagging effect of fused coal ash on the firebrick lining of the kiln furnace may be a serious problem in kiln maintenance. The molten ash attacks and dissolves the refractory or it may form clinkers along the side wall which must be broken off and when cleaned may carry away sections of the brick with it. Certain coals have an appreciable content of salt which is volatilized and carried into the kiln with the combustion gases. The effect of this in scum formation has been noted. The adaptation of stokers to kiln firing is, as yet, in the experimental stage. The use of powdered coal is also in the stage of development for ceramic firing, although one or two installations are in use. The principal difficulty involved is the ash carried by the flame and its effect on ware being fired. E.J.V.

A study of certain American coals. A. M. BALL AND H. A. CURTIS. *Ind. Eng. Chem.*, **22** [2], 137–40 (1930).—A study was made of various American bituminous coals to determine their behavior in the neighborhood of their softening temperatures by the gas-flow method and also under reduced pressure and upon single pieces of coal. It is shown that coals differ widely in their softening points, in their sensitivity to oxidation and preheating, in degree of fluidity reached above their initial softening points, and in the degree of plasticity below their softening points. R.G.M.

Burning fuel in downdraft kilns. ANON. *Brit. Clayworker*, **39** [456], 30–31 (1930).—The ordinary combustion of coal in a kiln takes place in 3 stages: (1) The air passing through the grate and beds of fuel forms carbon monoxide, which is burned almost at once, forming carbon dioxide, the heat developed being used for firing the ware. (2) Hot carbon dioxide cannot exist in the presence of hot coke so that a portion of the gas is reconverted into carbon dioxide. (3) Any volatile matter in the fuel is converted into gas which resembles an impure "town's gas." Downdraft kilns ought always to be provided with fireplaces of such depth that they act as semigas producers, regardless of the use of flat or sloping fire bars. The amount of useful gas (carbon monoxide) produced by passing air through a thick bed of fuel depends partly on the reactivity of the fuel, which varies with its origin, partly on the temperature, and partly on the time of contact. R.A.H.

Treatment of fine coals. ARTHUR GROUNDS. *Colliery Guardian*, **140** [3604], 318–20 (1930).—Some of the recent developments in the treatment of fine coals are discussed. These include use of vibrating screens, slurry formation in the washery, cleaning of slurry, froth flotation, "up-grading" slurry, rotary filters, and drying of the fine coal. E.J.V.

Relative inflammability of coal dusts. A. L. GODBERT AND R. V. WHEELER. *Colliery Guardian*, **140** [3602], 131–33; [3603], 224–26 (1930).—A laboratory method for measuring the inflammability of coal dust consists, briefly, in determining "the amount of inert dust required in a mixture with coal dust to suppress the ignition of the dust." The present paper describes the method in detail and a record is given of experiments made to check its reliability. By its use, a study has been made of the relationship between the chemical composition of coal dusts and their inflammability. A simplified form of the method is suggested for routine tests. E.J.V.

Characteristics of American and British coals. REINHARDT THIESSEN AND WILFRID FRANCIS. *Colliery Guardian*, **140** [3602], 142 (1930).—A brief discussion of the more obvious differences between British and American coals is given. E.J.V.

Pulverized fuel. J. T. DUNN AND BURROWS MOORE. *Colliery Guardian*, **140** [3615], 1384–87; [3616], 1473–75 (1930).—The properties which govern largely the choice of a fuel to be used in powdered form are discussed in detail: (1) friability, (2) moisture content, (3) ash content, (4) volatile matter, and (5) availability of fuel. The combustion aspects are (1) combustion of the powdered fuel in masses ranging from invisible to active visible combustion and (2) combustion of the fuel finely dispersed. The principal factors directly controlling combustion temperature are (1) rate of oxidation and decomposition, (2) dissociation of the reaction products, (3) the mean heat capacities of the gaseous products, and (4) heat losses due to conduction and radiation from the hot combustion gases. The principal factors controlling completeness of combustion are (1) intimate mixing of fuel and air in correct proportions, (2) degree of fineness of particles, (3) preheating of the air, and (4) uniform rate of supply of the mixture of fuel and air to the combustion chamber. The combustible capacity is determined by (1) the amount of heat produced and (2) the rate of production of heat. The method in general use has been the determination of the calorific value by a bomb calorimeter. The two principal systems of pulverized fuel firing are described. The temperature rise during pulverization and the dissipation of this heat is explained. The characteristics of units for feeding the fuel from the bins to the pipe lines are (1) accessibility, (2) high-moisture handling capacity, (3) reliability, (4) capacity for preventing arching in the bin, (5) uniform delivery, and (6) low dust leakage. A burner should have (1) high adjustability and adaptability, (2) capacity for operating with low air pressures, (3) capacity for delivering a uniform mixture of air and fuel, and (4) capacity for operating at high and changing temperatures. Two types of success-

ful burners are (1) grooved burner nozzle giving a helical motion and (2) staggered vanes which impart changes of direction to the coal-air stream. The principal factors governing the size and shape of the combustion chamber are (1) time allowable for combustion, (2) avoidance of contact of hot flame with chamber walls, (3) fuel consumption, (4) method of cooling the linings of the chamber, (5) the type of process for which the fuel is required, and (6) the space available. 25 to 35% of excess air is found to be suitable with coal in powdered form. The necessity for special refractory linings has been greatly lessened by water-cooling arrangements, but refractory linings are desirable since they maintain sufficient incandescent surface for proper combustion in cases where fuels of low volatile content, such as coke or anthracite, are used, or in cases where combustion space is necessarily limited. E.J.V.

Value of finely-pulverized coal. ANON. *Pit and Quarry*, **19** [5], 86 (1930).—To obtain instantaneous combustion of any combustible material it is necessary to increase the surface of the material being burned. Thus, coal of extreme fineness burns so quickly that most people would call its combustion an "explosion," much like the burning of gas. Even fuel oil must be pulverized or "atomized" before it will burn properly under a boiler. It is an acknowledged fact that the more thorough the atomization of the oil the better the combustion, because the more finely divided the oil the closer is its approach to the ideal gaseous state. Similarly, the finer the pulverization of coal the closer is its approach to the ideal gaseous state. E.P.R.

Treatment of coal. C. H. LANDER. *Queensland Govt. Mining Jour.*, **30** [11], 471 (1929).—In a lecture on the treatment of coal, at the Royal Society of Arts in London, L. discussed some of the more recent work carried out on the constitution of coal, and dealt at some length with high-temperature carbonization processes and coke treatment, and with some of the problems of the gas industry. E.P.R.

Chemical nature of coal. FRIEDRICH BERGIUS. *Queensland Govt. Mining Jour.*, **30** [8], 395 (1929).—At the Pittsburgh conference of Bituminous Fuel, B. gave account of his investigations on hydrogenation. The paper concerns part of the labor carried on by Karl Schoenemann during the last year. The task was to study the formation of coal from cellulose and lignin. B. points out the simple stoichiometric relation between quantities of applied cellulose and the resulting quantity of carbonic acid and water. $C_6H_{10}O_5 = CO_2 + 2H_2O +$ (end coal + by-products). The results of the investigation show that the end coal resulting from cellulose is closely related to natural coal and that it is very likely that a considerable proportion of natural coal is derived from cellulose. E.P.R.

Determination of mineral matter in coke. K. HRADSKY. *Gas Age-Rec.*, **65** [18], 650 (1930).—The relation between the true mineral content of coke and the composition of the ash is discussed. If the coke contains little sulphur and no sulphate the ash is free from sulphate. Sulphate in the ash is not derived from organic sulphides. The sulphur in the ash is unchanged by addition of lime to the coke. The coke sample, weighing from half to one gram, is treated in a porcelain boat with dilute acetic acid, 3 to 5 cu. cms., dried, and washed in air or oxygen at a temperature of 700 to 800°C. The ash is reduced with dry hydrogen at the same temperature and cooled in hydrogen. After further treatment with acetic acid and reduction in hydrogen the ash is weighed. The iron in coke is present as the element or as ferrous sulphide. F.P.H.

Coke sets record. ANON. *Chem. and Met. Eng.*, **37** [1], 33–35 (1930).—Output of coke during the year was largest ever recorded, being 11.3% greater than in 1928, the previous record year. Maps, charts, and tables are given. G.R.S.

Some properties of coal dust and pulverized coal. F. S. SINNATT. *Colliery Guardian*, **140** [3616], 1478–79 (1930); for abstract see *Ceram. Abs.*, **8** [6], 438 (1929). E.J.V.

Distillation of finely-divided coal. TRICKNUNGS-, VERSCHWELUNGS-, UND VER-

GASUNGS-G.M.B.H. *Colliery Guardian*, **140** [3606], 561 (1930); for abstract see *Ceram. Abs.*, **8** [11], 838 (1929). E.J.V.

Coal washing investigations. ANON. *Engineering*, **129** [3344], 196 (1930).—The washing processes are discussed under the headings: gravity stratification, float and sink processes, and non-gravity processes; the last class includes both flotations and oil amalgams. In all three classes wet and dry processes are distinguished. Magnetic and electrostatic separators are merely mentioned. *Bulletin*, No. 300 of the Bureau of Mines, on Coal Washing Investigations, Methods and Tests by F. H. Yancey and Thomas Fraser is discussed. See also *Ceram. Abs.*, 9 [3], 222 (1930). A.A.

Smoke abatement and its relation to brickmaking. ANON. *Brit. Clayworker*, **38** [455], 445–47 (1930).—There are 3 methods of preventing black smoke from kilns: (1) burning the fuel so that no black smoke is produced; (2) burning the smoke, and (3) trapping the smoke before it reaches the chimney. The first method is converting the fuel into gas and the kiln into a gas-fired kiln. If solid fuel is supplied mechanically the amount of black smoke can be made negligible. No matter how carefully a periodical kiln is fired it will be impossible to prevent smoke during certain stages. Smoke prevention is easy when a short flame will suffice but extremely difficult when a long flame is needed. In many intermittent kilns the smoke is burned fairly completely during the full fire stage because the contents are at so high a temperature and the gases and air are so thoroughly mixed by the "baffling" action of the ware. In a continuous kiln of sufficient length, the number of preheating chambers ought to be great enough to insure the complete combustion of the smoke, but in many kilns this does not occur. Various appliances can be inserted between the boiler or furnace, or kiln and the chimney, but this method is wasteful since no use is made of the heat evolved. The most novel method of trapping the smoke is electrical precipitation on a series of fine wires suspended in the chimney. So far the only method which can effectively deal with smoke which has left the kiln and is about to enter the chimney is to provide a washing device. Such devices cause the chimney to be practically useless as a draft producer and it is necessary to place a fan in the system to produce a draft. R.A.H.

Applications of thermodynamics of interest to gas engineers. D. L. JACOBSON. *Gas Age-Rec.*, **65** [18], 643–46 (1930).—From a practical point of view every chemical reaction has corresponding value for the change in free energy in calories in the same way that it has a heat of reaction in calories. The free energy value indicates the "potential" of the reaction, *i.e.*, it is a measure of the driving force tending to drive the reaction to equilibrium. When equilibrium is reached, the driving force is zero and the free energy is zero. The standard conditions for which free energy is calculated, in the case of gases, assume each gas to be at one atmospheric pressure. While free energy is the measure of the driving potential, it gives no information on the rate of reaction and further information on the rate of reaction must be obtained to complete our knowledge of a particular reaction. F.P.H.

Fuel gas technique: some modern developments. L. H. SENSICLE. *Chem. and Ind.*, **49** [5], 57–66 (1930).—Fuel gas for industry is derived from (1) statutory gas undertakings, (2) nonstatutory gas suppliers, (3) producer or other gas made on consumers own works, and (4) limited special sources of compressed gas in cylinders for welding, cutting, etc. For successful utilization of gaseous fuel, one essential is constant gas quality. In England the Boys calorimeter is used for official spot testing. Automatic recordjng apparatus for calorific value are represented by Fairweather and Thomas apparatus. Klonne tankless gasholder and the M.A.N. waterless holder, new types of low-pressure gas holders are described. When gas is burned three different types of admixture with air for combustion can be distinguished: (1) no primary air is mixed with gas before it is burned, (2) part of necessary air is mixed with gas, and (3) all the

air required is mixed with gas before combustion. In practice (2) is most common. Recent developments such as the surface combustion burner, and the submerged combustion burner under (3) are discussed. Corrosion, internal and external, of transportation mains and pipes is an important problem. Gum formation in stored gas should be studied. See also *Ceram. Abs.*, 9 [6], 458 (1930). G.R.S.

Testing gas coals. J. G. KING AND L. J. EDGCOMBE. *Colliery Guardian*, **140** [3608], 715 (1930).—This investigation covers variations caused by two types of gas-making plants and those caused by differences in the type and size of coal. Accurate data were available from both plants on yields from three types of bituminous coal and from three ranges of coal size. One coal is typical of the fusible coals normally used for gas manufacture, a second of equal value for the production of gas, but less fusible, and a third less strongly caking and, for this reason, outside the class of normal gas coals. It has been possible to compare the assay results obtained from eight different coals, all of gas-making type, with yields obtained by carbonization in continuous vertical retorts using 5% of steam. From the data obtained it may be concluded that the factors, for the calculation of retort yields from those of the assay, vary with type of retort and with type and particle size of coal. They may also vary with individual retorts of the same type, though to a much less extent. E.J.V.

Submerged combustion. C. FEATHERSTONE HAMMOND. *Colliery Guardian*, **140** [3608], 713 (1930).—In the Hammond system, fuel and air in chemically correct proportions are introduced into a mixing appliance constructed of laminations with a special form of piercing, so that when assembled, the holes form tubes, from which ducts lead the gas and air into the mixing chamber formed by a large central hole. From this the gas and air emerge in the form of jets and the cross-sectional areas of the passages are such that these streams or jets are of approximately equal velocity and have therefore no superior kinetic energy either in the gas or air streams. These streams readily diffuse into one another in the mixing chamber to form a perfect homogeneous mixture of uniform composition, and with this perfect mixture it is found that the rate of combustion achieved in the combustion chamber of the burner is 200 times that obtained in the combustion chamber of a high-duty boiler under forced draft. The flame generated in the above way is sufficiently stable to be unquenchable. E.J.V.

Calculation of gas calorific values by nomogram. F. JONES. *Colliery Guardian*, **140** [3607], 607 (1930).—"Nomogram" is a graphical representation of a formula by the use of which any number of calculations, whose conditions satisfy that formula, can be worked out. If, in the case of gases, the total heat units of the heat-giving constituents (unsaturated hydrocarbons, carbon monoxide, hydrogen, and methane) are represented by the sumbols m, n, p, and q, a simple formula is obtained from which the calorific value of any gas can be obtained: $CV = m + n + p + q$. A typical diagram is shown and explained in detail and the method of calculation by use of the nomograph is illustrated. E.J.V.

Producer gas practice. VICTOR WINDETT. *Brick Clay Rec.*, **76** [9], 583 (1930).—Producer gas is of lower calorific value than ordinary city or by-product coke-oven gas and has a relatively low luminosity. The heat value of a typical producer gas is calculated. Producer gas is a suitable fuel when a low cost source of heat is needed in large volumes for furnaces using great masses of heat, and is especially useful where a soft heat from a noncutting and nonoxidizing flame is desired. The relative value of producer gas and some competing fuels is given. A great deal of investigation and full scale experimenting has been done on the low carbonization of coal to produce a smokeless fuel substitute for anthracite. A process akin to the low carbonization idea has been worked out and a large plant using it is in successful operation in Chicago. E.J.V.

Gas producer practice. O. S. SCALES. *Brick Clay Rec.*, **76** [9], 583–84 (1930).—Certain general qualifications necessary in any coal before it is at all adaptable for use in the gas producer include: (1) fusion point of the ash must be above 2200°F; (2) coal with volatile content in excess of 42% is not desirable; and (3) ash in excess of 8% is burdensome to handle in the producer and no coal whose ash exceeds 10% should be used. In order to understand some of the problems of producer gas generation it is necessary to understand the fundamentals underlying the generation of carbon monoxide gas. A brief explanation of CO generation and some specific directions in regard to operation of the producer are given. E.J.V.

Industrial gas subject to new factors. R. S. MCBRIDE. *Chem. Met. Eng.*, **37** [1], 36–38 (1930).—Power sources are briefly discussed. Reserves of natural gas are greater than estimated. Other kinds of gas which may supplant or supplement manufactured gas are (1) coke-oven gas now uneconomically conscripted for steel plants and oven firing, (2) petroleum-refinery vent gases, and (3) propane and butane recovered and wasted to the extent of three-quarters of a million gallons a day. G.R.S.

Linde plants for coke-oven gas decomposition. ANON. *Engineering*, **129** [3343], 163–66 (1930).—Decomposition of coke-oven gas by the process of the Gesellschaft für Linde's Eismaschinen A.-G. of Höllriegelskreuth, near Munich is described and illustrated. A.A.

Characteristics and combustion of fuel oil. T. J. ESS. *Blast Fur. Steel Plant*, **18** [4], 648–52 (1930).—Oil burners are really atomizers or vaporizers which change the liquid fuel into a fine mist or gas. They are divided into three general classifications: (1) mechanical burners in which the oil is atomized by the pressure of the oil alone; (2) spray burners in which the oil is atomized by a stream of air or steam; and (3) vaporizers which turn the oil into a gas. Burners have also been developed employing combinations of these three methods. Combustion rates for fuel oil run from 20,000 to 40,000 B.t.u. per hour per cu. ft. of furnace volume. This corresponds roughly to $\frac{1}{2}$ to 1 cu. ft. per lb. of oil per hour, or in boilers 1 or 2 cu. ft. of volume per boiler horsepower developed. Modern installations run to the higher combustion rate. While it is true that a higher rate of heat liberation can be obtained with mechanical atomizing than with steam atomizing due to the shorter flame produced, the higher flame temperature thus produced will shorten the life of the refractories. For this reason it is best to figure the same rate of heat liberation regardless of the type of atomization. Combustion can be steadied if the flame is near a wall or floor. The heat thus radiated to the flame makes ignition easier. In boilers about 1 sq. ft. of radiating surface should be allowed per boiler horse-power developed. Impingement of the flame, however, should be avoided, as it increases maintenance and may tend toward localization of heat. If oil flames strike any cool surface before combustion is complete, soot is deposited. F.P.H.

Assay of coal for carbonization purposes. III. Correlation with coal gas manufacture. ANON. Dept. Sci. Ind. Research. Fuel Research, *Tech.* Paper, No. 24; reviewed in *Gas Age-Rec.*, **65** [13], 430 (1930).—This paper is the third dealing with the assay of coal for carbonization purposes, the earlier papers being Technical Papers Nos. 1 and 21. No. 1 dealt with the development of an apparatus for testing coals for carbonization at temperatures of about 600°C, and which was therefore especially suitable for coals to be used for low-temperature carbonization. No. 21 gave fuller details of the considerations leading to the choice of the particular form of apparatus and described modifications in procedure that had been found necessary when testing highly swelling coals. The present paper deals with a modification of the apparatus which is intended to make it more suitable for testing coals to be used in gas retorts. The yields obtained from any given coal in gas-works practice depend on the type of

retort used and the method of working, so that the factors correlating the assay yields with those obtained in commercial practice vary with the type of retort, extent of steaming, size of coal, and to some extent with the nature of the coal. Correlation factors are given for a number of different conditions indicating how these factors vary. F.P.H.

Carbonization of bituminous and brown coals. F. FISHER, T. BAHR, AND H. SUSTMANN. *Brennstoff Chemie*, **11**, 1–9 (1930); *Gas Age-Rec.*, **65** [16], 546 (1930).—Strong, coherent, and dense semicokes have been produced by the carbonization of noncaking or highly swelling coals at a temperature of 600°C in an autoclave wherein the pressure developed by the gas evolved was permitted to rise to a predetermined value and was maintained thereat until carbonization was complete. Thus a coal which gave a feebly coherent coke of apparent specific gravity 0.67 under normal carbonizing conditions, yielded an exceptionally strong coke of apparent specific gravity 0.88 when carbonized under a gas pressure of thirty atmospheres. The type of coke produced by this process depends on the gas pressure reached while the material is in the plastic state. To obtain the coke of maximum strength and density from some coals it was necessary to supplement the pressure due to the gas involved by the introduction of compressed nitrogen. F.P.H.

Low-temperature carbonization. ANON. *Colliery Guardian*, **140** [3614], 1286–87 (1930).—The Abder-Halden process, designed for the low-temperature distillation of fine and pulverulent coal, produces a semicoke having approximately the same appearance as the original coal. The main feature of the method is that the semicoke remains pulverulent, or at least agglomerated in very small pieces, even when coals of the caking type are distilled. Illustrated. E.J.V.

Plassmann process for the low-temperature carbonization of coal. DAVID BROWNLIE. *Gas Age-Rec.*, **65** [16], 541–43 (1930); for abstract see *Ceram. Abs.*, **8** [2], 141 (1929). F.P.H.

Dvorkovitz system of low-temperature carbonization. ANON. *Queensland Govt. Mining Jour.*, **30** [8], 385 (1929).—The process itself has various distinctive features and operates at least on certain types of coal with success. External heating of the retorts by producer gas is supplemented by the introduction of superheated gas (the product of the carbonization process after its final stripping of the condensable fractions) at a temperature of 350 to 400°C, which is passed downward through the charge and carries off the volatile matter distilled from the coal. The temperature of the retort is kept below 500°C, and the production of uncondensable gas is claimed to be so low that it is not sufficient to serve for the external heating of the retorts and the superheating of that portion which is used as carrier gas. E.P.R.

Babcock low-temperature carbonization plant. ANON. *Colliery Guardian*, **140** [3617], 1589–90 (1930).—A detailed description of a low-temperature carbonization plant in use in England is given. Illustrated. E.J.V.

Low-temperature carbonization. The "Babcock" process. DAVID BROWNLIE. *Chem. and Ind.*, **49** [5], 92–94 (1930).—Instead of burning raw coal direct, it is first given a low-temperature carbonization (900 to 1000°F or 480 to 540°C), the residual solid fuel with 10 to 12% volatile matter is then used for combustion. Gases and vapors are passed through a condensing and scrubbing plant for recovery of tar and light oils. The residual gas is burned. From $^1/_4$ to $^1/_3$ more coal is required but 16,000 to 20,000 gals. of tar and 2000 gals. light oil are recovered per 1250 tons of coal used. Diagrams and photographs are given to illustrate the principles of the process. For previous abstracts see *Ceram. Abs.*, **9** [2], 122; [1], 57 (1930). See also D. Brownlie, 1929 Author Index, p. 955 for *Ceram. Abs.* G.R.S.

Low-temperature carbonization. ANON. *Brit. Clayworker*, **38** [455], 469 (1930).—

A short discussion with data on the method of carbonizing waste coal or fuel. R.A.H.

Coal processing yields new gains in production. ANON. *Chem. Met. Eng.*, **37** [1], 33 (1930).—Low-temperature carbonization seems to be an economic failure under American conditions at present. There has never before been a time when the interlocking of the fuels and the energy resources of the U.S. were so intimate, nor has there ever been a time when changes in source of energy and fuel have been taking place so rapidly, or with the potentiality of so great an economic advance, and ever serious disturbance of present profitable operation. G.R.S.

Rational firing. F. NIEBLING. *Tonind.-Ztg.*, **54** [24], 405–408 (1930).—The content of carbon monoxide and carbon dioxide in flue gases is important for the efficiency of firing. About 9.6 cu. m. of air are required to burn 1 kg. of fuel. The amount of air needed for burning can be calculated exactly in the case of every fuel. In ceramic kilns there is always a surplus of air which amounts to about double the air required for firing. The following processes influence the firing: (1) Opening of the fire door lowers the temperature as it permits the entrance of cold air into the firing zone. (2) Addition of fresh fuel reduces the heat and the temperature is lowered. (3) When the fire is charged, there is not enough air and the burning is not complete; carbon monoxide is formed and smoke appears. Unburned particles of combustibles are drawn away by the draft; there is a loss of fuel and reduced firing. (4) When the fire is well started and combustion is complete carbon dioxide is formed and the temperature rises. (5) When the fuel bed becomes completely ignited only small quantities of oxygen are needed, but excess air enters which must be heated and an oxidizing flame results. To insure a rational firing it is necessary to maintain a continuous uniform firing and to avoid sudden changes. Also, it is necessary to ascertain the composition of flue gases and the quantity of air required. The latter is obtained by measuring the draft. There are different apparatuses for this purpose. Uniform feeding of the fuel can be done automatically. The fuel should be in the form of small coals when there is a large grate surface; also coal or coke dust can be used if the draft is not very strong. In periodical single kilns there should be a small surplus of air up to 300°C. In permanent kilns the surplus of air must not exceed double the quantity of air theoretically necessary if the charge is damp. If the ware is dry or well smoked the surplus of air is lowered. In firing clays containing iron a surplus of oxygen is needed to obtain the red color by oxidation. Reduced firing and a lack of air are used to obtain dark colors. M.V.K.

Chemistry and physics of combustion of gaseous fuels. G. E. SEIL, H. A. HEILIGMAN, AND C. N. WITHROW. *Ind. Eng. Chem.*, **22** [2], 179–85 (1930); for abstract see *Ceram. Abs.*, **8** [12], 909 (1929). R.G.M.

Transmission of heat between fluids in motion. I. A. MONDIEZ. *Chaleur ind.*, **11**, 117–25 (1930).—M. develops the classical theory for the case of flow in the same and that of flow in opposite directions. The calculations are then derived by a more exact method. II. *Ibid.*, **11**, 188–96.—M. decides that in some cases opposite flow is more advantageous, in others the flow should be in the same direction, and in still others the two methods are equivalent. A.J.M.

Heat transfer from gases to solids. ANON. *Queensland Govt. Mining Jour.*, **30** [8], 382 (1929).—The efficiency of a number of industrial processes, such as the blast furnace, gas producer, and lime kiln, depends upon the proper transfer of heat from moving gases to colder solid particles. In general, heat transmission is a function of the physical properties of the mass of solid particles. The Bureau of Mines, in coöperation with the Univ. of Minnesota, has started an investigation for obtaining quantitative information which will guide operators in making such innovations in practice

as will best satisfy the thermal requirements of their processes. The transmission of heat from water flowing through a bed of steel balls, about 1 in. in diameter, is being studied first with a view of finding some fundamental relations that can be applied to systems in which heated gases are passed through a mass of irregular-shaped particles of relatively low heat conductivity. E.P.R.

Heat transfer in regenerative systems. II. GEORGE V. SLOTTMAN. *Blast Fur. Steel Plant*, **18** [4], 624–26 (1930).—The effect of the dimensions of the regenerator and of the flue size is discussed with reference to practical operations. The Loftus, Danforth, and Peterson brick aim to improve the regenerator operation by (1) preventing the pugging of the lateral passages, (2) by increasing the heating surface per foot of regenerator height without changing the flue size or the heat transfer coefficient, and (3) by providing for a tortuous flow of the gas streams through the checker, increasing the turbulence and thereby the rate of heat transfer. The added cost of brick must be balanced against the saving in fuel and the increase in tonnage. (1) Formulas are developed for the approximate calculation of regenerators. (2) It is shown that the rate of heat transfer is determined by the gas velocity in the flues. (3) With a given flue size, the preheat is determined by the height of the regenerator, the cross-sectional area of the checker having little influence except in determining the pressure drop. (4) The preheat temperature is governed by the height of the regenerator, the size of flue, and the ratio of volume of waste gas to volume of air. (5) Special brick shapes increase the rate of heat transfer, the heating surface, or provide against plugging. (6) The average brick temperature varies with the inlet gas temperature and the ratio of the volume of waste gas to the volume of air. (7) An optimum time of cycle exists for each regenerator, which must be determined experimentally. For Part I see *Ceram. Abs.*, **9** [6], 461 (1930). F.P.H.

Residue on ignition and mineral content in fuel analyses. A. STADELER. *Stahl Eisen*, **50** [7], 208–209 (1930).—Mayer has developed a control method for analyzing coal containing large quantities of minerals and whose residue on ignition consists of a considerable quantity of ingredients soluble in hydrochloric acid. Mix 2 g. of powdered coal sample in a beaker with 100 cu. cm. of 5% of hydrochloric acid, heat to 80°C for two hrs. in a water bath, filter through a tared Jenaer filter crucible, wash by decantation and filter till free from chlorine, dry to constant weight, and weigh. The loss of weight so determined corresponds to the content of water plus mineral ingredients soluble in acid. Half of the completely dehydrated, extracted sample is weighed and put in a platinum crucible and coked at a weak red heat. The weight of the residue on ignition corresponds to the silicates plus the weight, if any, of the iron oxide derived from pyrite. The pyrite content is ascertained by digesting this residue on ignition with approximately 15 to 20% hydrochloric acid for 3 hrs. at 80°. The iron which went into solution by this treatment is calculated back to pyrite. M. used this method of analysis for determining the mineral ingredients of many samples of coal and was able to discover the errors of former determinations. M.V.K.

Fuel economizers. O. KUBALEK. *Colliery Guardian*, **140** [3603], 222–23 (1930).—The construction, materials, and recent developments in fuel economizers are discussed. E.J.V.

Fuels and fuel testing in Canada. ANON. *Engineering*, **129** [3344], 234 (1930).—The division of fuels and fuel testing of the Canadian Government Department of Mines deals in its Mines Branch Report No. 696 with Investigations of Fuel and Fuel Testing of 1927, conducted with the object of developing the economic utilization of the country's fuel resources. A.A.

BOOKS AND BULLETINS

Coal Carbonization. R. WIGGINGTON. Pp. 10 + 287; 47 figs. in text. Bailliere,

Tindall & Cox, London, 1929. Price 21s. net. Reviewed in *Colliery Guardian*, **140** [3601], 81 (1930).—W. outlines the chemistry of coal carbonization from an academic rather than a technical standpoint. The first two chapters deal with the early history and later developments of coal carbonization. The development of modern gasworks practice is traced. The difficulties arising in the determination of the quantitative elementary composition of the pure coal substance, and the various systems of coal classification are explained. The purification of crude coal gas is discussed in the light of recent experience, both in England and in America, and Deville's experiments illustrating the variation in the composition of coal gas from various types of coal are described. A chapter is devoted to coke. W. traces the effects observed in heating single particles and small pellets of coal, and the laboratory experiments on powdered coal as carried out recently by Lambris, Lessing, and others. These, together with the experiments of Foxwell and the work of Audibert, throw light upon the so-called softening of coal on heating. Much research has been carried out on the fusible constituents of coal, and the treatment of this subject will be widely appreciated. E.J.V.

Transmission of Heat. (La transmission de la chaleur.) TEN BOSCH. Published by Dunod, Paris. 372 pp., 169 figures. Translated from the 2nd German ed. Reviewed in *Chaleur ind.*, **11**, 166 (1930). A.J.M.

Coke Oven Practice. (Kokereiwesen). H. HOCK. 172 pp., with 32 figs. and tables. Theodor Steinkopff, Dresden and Leipzig, 1930. Price, paper, 14 Rm; bound 15.50 Rm. Reviewed in *Colliery Guardian*, **140** [3613], 1201 (1930).—In a general introduction to this handbook H. reviews the progress of the industry, both in output and value and gives statistical information illustrating its rapid growth. The second section deals with coking coal. Current theories respecting the origin of coal and prevalent divergent views respecting the relative parts played by lignin and cellulose in its formation are discussed. The petrographic constitution of coal and its influence on coking properties are described. A description is given of various coal washing methods, including modern flotation processes, in which reference is made to the Arzinger process recently introduced in America, and a concise account is given of methods of dry washing practised in America and England, with critical comments on their advantages and disadvantages. In the coking process, a comprehensive account is given of modern researches on the various phenomena which characterize the formation of coke. This is followed by an account of the various types of coke ovens, on which H. comments briefly. In the fourth section of the book the properties and uses of coke are considered. Among these combustibility and reactivity are treated. The last section deals with coke-oven gas and its treatment for the recovery of tar, ammonia, etc. Many processes for the removal of sulphurous and other impurities from coke-oven gas including some of recent introduction, are described, and H. concludes with an interesting discussion of the uses of coke-oven gas. The conversion of coke-oven gas into by-products, such as hydrogen gas, for the production of synthetic ammonia and for hydrogenation processes are reviewed. E.J.V.

Fundamentals of Coke Chemistry. (Grundlagen der Koks-Chemie.) O. SIMMERSBACH. 3rd ed., revised by G. Schneider. 366 pp. 74 text figures. Julius Springer, Berlin, 1930. Price 39 Rm. Reviewed in *Colliery Guardian*, **140** [3614], 1288 (1930).—The book is divided into three parts: (1) a general discussion of the subject; (2) properties of coke; and (3) methods of testing its chemical and physical properties. The book is a compendium of what is known about this subject and also of much that still remains to be investigated. E.J.V.

Green chain grate stoker (natural draft). ANON. *Pit and Quarry*, **19** [5], 100 (1930).—The Combustion Eng. Corp. has issued a catalog describing and illustrating

mechanical stokers for burning the screenings from all grades of noncoking or moderately-coking bituminous coals, high-ash coals, and many lignites. E.P.R.

PATENTS

Tunnel-kiln car. GEORGE D. MORRIS. U. S. 1,755,701, April 22, 1930. A tunnel kiln car comprising a metallic bottom frame member, a refractory body portion mounted thereon, transverse girders mounted on the body portion and having a longitudinally extending recess in the top surface thereof, and a goods supporting platform consisting of a plurality of slabs supported by the girders, adjacent slabs being arranged with the joint therebetween positioned over one of the recesses.

Making brick. ARTHUR J. THERRIEN. U. S. 1,757,786, May 6, 1930. Process of setting brick in a kiln which comprises forming a plurality of individual piles of unfired brick, each pile having a transverse arch therethrough, and assembling the piles with the arches in alignment.

Tunnel kiln. ARTHUR MCDOUGALL DUCKHAM. U. S. 1,758,785, May 13, 1930. A recuperative annular muffle kiln of the kind herein referred to, wherein water vapor is removed, under control, from the kiln chamber at one or more points between the charging point and the zone of open heating for the purpose set forth.

Disintegrating and conveying powdered fuel to burners. GESELLSCHAFT FÜR RATIONELLE VERBRENNUNG, M. B. H. Brit. 299,708, 1928; *Colliery Guardian*, **140** [3610], 953 (1930).—The atomizing or disintegrating and conveying means consists of a tubular casing which is divided at a suitable point by means of a partition, furnished with one or more series of apertures. In front of the partition and conforming therewith is provided a disk, which is freely rotatable and is also furnished with one or more series of apertures. The apertures in the partition and in the rotary disk are angular to each other, and the rotation of the disk is effected by a current of gas or air caused to flow through the apertures in the fixed wall and striking against the walls of the apertures in the disk. The atomizer may be employed both for liquid as well as pulverulent or solid fuel. The fuel is introduced in the center of the casing to the space which is bounded on the one hand by the fixed partition and on the other hand by the rotary disk. It flows against the rotary disk, and by the action of centrifugal force is flung toward the edge where it forms a film over the mouth of the apertures. The moving current of gas or air which causes the rotation of the disk flows axially and after penetrating through the apertures in the fixed wall strikes against the walls of the apertures in the rotary disk, giving a rotary effect similar to that occurring in a turbine. The atomization or disintegration of the fuel is performed by this current of air or gas, which breaks up the film of fuel covering the mouths of the apertures in the disk. The central feed pipe may also be made to be displaceable, so that the fuel is then introduced not exactly at the center, but at certain points between the center and the periphery of the disk. E.J.V.

Low-temperature distillation of fuels. A. J. A. HÈRENG. Brit. 322,332, Jan. 22, 1930; *Colliery Guardian*, **140** [3615], 1425 (1930).—The invention consists in a continuous process for distilling raw fuels at a low temperature, consisting in drying the fuel and heating it up to the softening point; feeding the fuel thus heated onto a gas-pervious endless traveling member preferably a chain grate that forms the floor of a distillation chamber, and gradually heating the fuel during its travel through the distillation chamber up to the optimum temperature, below 500 °C, which causes distillation at a low temperature. The sources of heat employed for this purpose being any other available gases, or the actual heat of the gases passing through the fuel layer resting on the chain grate, the gases preferably being the distillation gases previously heated, whereby distillation can be conducted in a neutral atmosphere, or else heat

radiating from the walls of a combustion chamber or, lastly, the actual heat of the chain grate links. E.J.V.

Manufacture of agglomerated fuel. M. H. HUÉ. Brit. 323,698, March 5, 1930; *Colliery Guardian*, **140** [3610], 954 (1930).—The process consists in finely grinding wood-charcoal or semicoked peat or lignite, mixing it with petroleum tar dissolved in mazout, *i.e.*, the liquid remaining after refined spirit such as petrol or kerosene has been removed from crude petroleum, and agglomerating it by means of a press, the agglomerates thus obtained being, after exposure to the air, coked at a moderate temperature and then slowly cooled out of contact with the air. Details of the process are given. E.J.V.

Electric tunnel kilns. ELECTRIC FURNACE CO., LTD., AND W. J. MILLAR. Brit. 325,794, April 24, 1930. In tunnel kilns heated by resistance coils arranged horizontally in the refractory walls at different vertical levels, the coils may be independently connected, as required, to produce a required temperature gradient in the vertical direction of the tunnel. The resistances are preferably of varying length to allow of variation in the temperature gradient in the longitudinal direction. In a double-track kiln for firing pottery, groups of resistances displaced toward the respective inlet ends of the track are arranged in the side walls, and a group is arranged in grooves in a central panel formed by fire brick threaded on vertical rods of nickel-chrome. The brickwork of the roof and side walls is recessed at intervals to prevent air drafts along the kiln when the end doors are open. Air inlets controlled by dampers, and outlet flues in the raised portion of the roof, cause a transverse draft. Chambers fitted with counterweighted side doors and transfer trucks are provided at the ends of the kiln to facilitate charging and discharging, and signal lamps are provided to enable the operators to work in synchronism. The trucks are propelled by an electric motor driving a rack through a pinion. The motor is fitted with a clutch which slips at a given load, *e.g.*, if a truck meets an obstruction.

Annular kiln. H. KOPPERS. Ger. 457,413, Nov. 21, 1924. Fixed walls, provided with regulable apertures are suspended at intervals along the hearth of the kiln, while the firing points on the hearth are bounded on one side by preferably stepped structures and on the other by movable perforated plates which lean against the material being heated. The latter thus never comes into contact with the fuel. (*B.C.A.*)

Gas producer for carburetted water gas. ANON. Ger. 479,029, Jan. 3, 1925; *Gas Age-Rec.*, **65** [16], 565 (1930).—The gas is made from coke, and a mixture of steam and oil vapors is introduced into the column of fuel in the generator. The lower part of the shaft of the generator works just like an ordinary gas generator while the upper part has as its purpose the cracking of the mixture of steam and oil vapors, which is allowed to enter the apparatus at the section marking the separation between the two parts of the generator. The upper part of the generator is accordingly maintained at a lower temperature than the lower part. F.P.H.

Gas producer with carbonizing chamber externally and internally heated. ANON. Ger. 479,031, Feb. 21, 1926; *Gas Age-Rec.*, **65** [16], 565 (1930).—The carbonizing chamber is located on top of the gas producer and has the same vertical axis as the latter. The carbonizing chamber is built of fire-resistant material in the lower part and is provided with a regulatable connection between the producer and the external ring of the carbonizing chamber. F.P.H.

Geology

Cyclical sedimentation of the Pennsylvanian period and its significance. J. M. WELLER. *Jour. Geol.*, **38** [2], 97–135 (1930).—The Pennsylvanian strata of western Ill. exhibit a cyclical repetition of beds as follows: (1) sandstone and sandy shales,

(2) underclay, (3) coal, and (4) marine limestones and shales. Each cycle was initiated by uplift which was reflected first by erosion and later by continental deposition of clastic materials. This was followed by a long period of stability during which weathering developed a typical poorly-drained profile of weathering, now represented by underclay. Peat, later transformed to coal, accumulated in more or less extensive swamps. These conditions were terminated by subsidence so that the area was inundated by a shallow sea in which marine strata were deposited until uplift brought the cycle to a close. The cyclical repetition of beds is regional rather than local, and analysis of the conditions necessary for the formation and preservation of such strata over broad areas furnishes the basis for a reconstruction of the physiography of the Pennsylvanian period. The conception of widespread sedimentary cycles provides new criteria for correlation in Pennsylvanian areas, as a definite succession of strata not dependent upon certain key horizons is established. It also furnishes a new basis for paleontologic studies, since faunules restricted to different habitats may be grouped with regard to definite marine invasions and an approximation of the total marine fauna of each invasion may be obtained. G.R.S.

Diatomaceous earth in the Pacific Northwest. ANON. *Pit and Quarry*, **19** [4], 78 (1930).—Since the development of the large deposits of diatomaceous earth in southern Calif. and the increased number of uses of this material for structural and insulation purposes, a number of deposits have been investigated in the North Pacific region. Apparently a series of separated beds of fresh water origin extends from Quesnel in eastern British Columbia to Terrebonne, Ore. Deposits are found in southern Idaho, and in eastern Washington, near Wymer, Ellensburg, Vantage Ferry, the Puget Sound district, Tacoma, Lake Sammamish, Big Lake, on Whitby Island, and near Port Townsend. Not all of this material is loaded with carbonaceous matter. Many of the deposits contain material which when dry is a light gray color. Some of the whitest diatomaceous earth is to be found near Vantage Ferry. Some of the deposits have volcanic ash impurities which can be distinguished from the diatomaceous earth by its higher specific gravity, its harsh and gritty feel and the absence of diatom skeletons or fragments when studied under a high-powered microscope. The use of diatomaceous earth in Portland cement to increase the plasticity, to decrease the differential settling of aggregate, and to decrease the permeability, has created a new interest in the use of local material in large quantities. E.P.R.

Industrial products from diatomaceous earth. GORDON F. SONDRAKER. *Pit and Quarry*, **19** [4], 83–86 (1930).—In commercial uses of this material impurities are of little consequence if held within limits. Diatomaceous earth is used in heat-insulating material, to a large extent in concrete, and as filtering mediums. E.P.R.

Diatomite. BRISBANE. *Queensland Govt. Mining Jour.*, **30** [11], 458 (1929).—Diatomite is a mineral which is becoming increasingly employed in various industries. It is known by other names such as tripolite and fossil flour. Under the microscope the presence of the diatoms may be established, which provides an infallible test for diatomite. About 10,000 distinct species of diatoms have been identified and classified each being different in size, form, and design. Many of these minute shells are marked with engravings so fine that they can only be distinguished with the most powerful microscope; in some cases 125,000 to the inch. E.P.R.

Salt cake. G. A. GARDNER. *Chem. Met. Eng.*, **37** [1], 56 (1930).—Increased demand with decrease of production of by-product salt cake and niter cake may produce a shortage. Natural deposits are not being developed because of distant location and prohibitive cost of production. The cost of salt cake has increased constantly in the last few years. G.R.S.

Imports of salt cake on increasing scale. ANON. *Chem. Met. Eng.*, **37** [1], 56

(1930).—The imports of salt cake for the first 10 months of 1929 were 3 times the total imports of 1923. G.R.S.

Company to develop Texas potash deposit. ANON. *Pit and Quarry*, **19** [13], 88 (1930).—Production of potash on an extensive scale will be started soon in the Midland area of West Texas by the Texas Potash Corp. of Dallas, as a result of the discovery by E. P. Schoch, director of the Bureau of Industrial Chemistry at the Univ. of Texas, of a method for refining polyhalite ores. The potash deposits found in the Permian of West Texas are chiefly composed of polyhalite, a mineral made up of the sulphates of potassium, magnesium, and calcium. E.P.R.

Potash output expanded. J. W. TURRENTINE. *Chem. Met. Eng.*, **37** [1], 46 (1930).—A discussion of importations of potash. Developmental activities in various countries are briefly treated. G.R.S.

German potash output continues to increase. ANON. *Kali, Erz Kohle*, **26**, 195 (1929); *Pit and Quarry*, **20** [1], 87 (1930); for abstract see *Ceram. Abs.*, **8** [7], 539 (1929). E.P.R.

New process for recovery of mica from kaolin proves successful in North Carolina. H. J. BRYSON. *Ceram. Age*, **13** [3], 79–81 (1929).—All clay deposits in the region contain biotite and muscovite. Some plants recover all and some only minus 20-mesh material. The recovery is from 3 to 5 T. of mica for each plant. The process was developed by H. H. Gaines. The chief use is in the roofing trades and the average price of the mica is about $30 per ton. W.W.M.

General Mica Company's new plant salvages material from neighboring clay operations. R. CARL MOORE. *Pit and Quarry*, **18** [12], 57–58 (1929).—The recently erected Sparks Plant of the General Mica Co. is the newest plant in the country devoted to the salvaging of mica from clay mines as a by-product. The Sparks plant is located along the Clinchfield Railroad a short distance from the Toe River. It recovers the mica formerly lost in the waste rejected by one of the largest clay mines in the vicinity. E.P.R.

Alkalis. ANON. *Chem. Met. Eng.*, **37** [1], 53–54 (1930).—Ammonia-soda, electrolytic, and natural soda industries are summarized. A chart shows production for sale of bicarbonate, caustic soda, and soda ash derived from ammonia-soda products. Consumption trends, and increases in use are given. G.R.S.

Development of glass sands along Pacific coast. ANON. *Pit and Quarry*, **20** [1], 73 (1930).—Although a number of fairly pure deposits of glass sand exist on the Pacific Coast, these are at present being used only for the making of brown or amber glass. White glass sand is still being imported, mostly from Belgium. An iron content of 2 or 0.3% prevents the direct use of the domestic sand for white glass, but a number of commercial organizations are attempting to work out methods of beneficiation of local materials. E.P.R.

Deposits and practices in phosphate district of Florida. J. R. CUDWORTH. *Pit and Quarry*, **19** [5], 77–79 (1930).—C. describes the geology of one type of phosphate mineral resource which supplies the bulk of the commercial demand by the manufacturers of fertilizers. He also explains the practices of stripping with draglines and of open-pit excavation of the valuable mineral by water under pressure. E.P.R.

Borax. P. V. MANNING. *Chem. Met. Eng.*, **37** [1], 55 (1930).—Marked increase in the production of borax during the past year with decline in price is studied. By far the greatest increase in its use was in the manufacture of glass, giving a superior product. Sources, amounts produced, prices, and exports of borax are outlined. G.R.S.

Relation between the chemical composition, microscopic structure, and ceramic properties of clays. ANON. *Corriere ceram.*, **11** [1], 33 (1930).—The microscopic

examination of a large number of clays showed that they seldom contain mica and consequently the alkali content must have another origin. Argillaceous material appears either in fine flaky kaolinite crystals, in a cryptocrystalline state, or as amorphous halloysite. Certain clays contain 16 to 18% soluble silica. It seems that there is some relationship between the $SiO_2 \cdot Al_2O_3$ content and the ceramic properties of plasticity and refractoriness. Many clays with a high silica content are equally fat as the silica is colloidal. Some clays rich in kaolinite crystals are less plastic than others with the same alumina content but having a halloysitic base. The refractoriness as well as the other ceramic properties do not depend entirely on the composition but more especially on different physical factors which a petrographical examination makes clear. M.V.K.

Zonolite producing at Libby, Montana. ANON. *Pit and Quarry*, **19** [5], 103 (1930).—Zonolite, a nonmetallic mineral composed of silica, magnesia, and alumina, is being produced on a commercial scale by the Zonolite Co. at Libby, Mont. The company owns large deposits and is operating at a capacity of 100 T. per day. The material has found wide use for insulating and fireproofing. Being lighter in weight than cork, in its expanded form, it is used as a cork substitute with marked success. E.P.R.

New occurrence of zunyite near Postmasburg, South Africa. L. T. NEL. *Chem. News*, **140** [3641], 60 (1930).—The mineral zunyite previously known only in Colo. has been found in some abundance in altered, highly aluminous shales and flagstones in the vicinity of the deposits of manganese ore. Minute tetrahedra are disseminated through the rock which also contains diaspore, kaolin, and leverrierite. Analysis agrees with the formula $Al_3(OH,F,Cl)_{12}(SiO_4)_3$. G.R.S.

Progress on the west coast. ANON. *Chem. Met. Eng.*, **37** [1], 26–27 (1930).—The present year promises to be one of great expansion in chemical manufacture on the west coast. The alkali industry is now in a position to care ably for the demand for strong alkali. Borax has had the best year on record. Practically all of the world's boron materials are produced in Calif., and even in face of the largest annual production price has begun to rise because of new uses. G.R.S.

Nonmetallics acquire greater stability. P. M. TYLER AND O. BOWLES. *Chem. Met. Eng.*, **37** [1], 40 (1930).—A brief discussion of the adverse factors affecting these industries and ways in which they may be overcome is followed by a survey of the following: abrasives, natural pigments, feldspars, fluorspar, and clays. Graphs are given to show the trends of domestic production of 12 of the more important nonmetallic raw materials. G.R.S.

Chromite in 1928. LEWIS A. SMITH. Bur. Mines, *Mineral Resources U. S.*, Part I, pp. 69–88 (1928).—Rapid expansion in the use of chromiuma began in 1922, was continued in 1928, and present indications are for continued increase in consumption. The most noteworthy developments in 1928 included the extensive adoption of chromium plating; the increased utilization of rustless iron and steel; and the further substitution of chromite refractories for magnesite refractories, due to the favorable price differential. Shipments of chromite from mines in the U.S. in 1928 were more than three times those in 1927, but were still relatively insignificant. Favorable development of the large chromite deposits of Southern Rhodesia continued in spite of the lack of adequate transportation facilities and a record output of 195,918 long tons was made in 1928. The rapid development of the Transvaal chromite area was a leading event in the Union of South Africa in 1928. Further discoveries of chromite have been made in Canada and Indo-China. In the U.S., 368 long tons of chromite were mined during 1928, and 660 T. shipped compared with 50 T. mined and 201 shipped in 1927. The U.S. imported 216,592 long tons of chromite during 1928, a decrease of 5768 T. from 222,360 T. imported in 1927. In 1927, the U.S. imported 55% of the total world pro-

duction, but in 1928 only about 49% of the probable world output. The largest use of chromite is in the manufacture of ferrochrome; this is followed by refractories which consume approximately 40%. The estimated world production of chromite in 1928 was about 449,000 metric tons, an increase of 41,000 over 1927. The price of the ore ranged from $22.00 to $25.00 per long ton f.o.b. eastern ports. The reports describe in detail the production and conditions in principal mining districts of the world. R.A.H.

Feldspar in 1928. OLIVER BOWLES AND JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources U. S.*, Part II, pp. 67–80 (1928).—Excessive production capacity and keen competition are reflected in conditions that prevailed at the end of 1928 in the feldspar industry. Although the output of crude feldspar in 1928, 210,811 long tons, was the highest on record, the average value per ton dropped for the second successive year. It was $6.73 in 1928, 31¢ lower than in 1927. The average values of crude feldspar in the U.S. in 1928, as reported by individual producers, ranged from $3.00 to $12.31. The output of crude feldspar in 1928 was 4% greater in quantity than that in 1927. The total value of the crude feldspar sold in 1928 decreased 0.4% compared with 1927 and 12% compared with 1926. The output of ground feldspar was also the highest on record, reaching 227,657 short tons or 2% more than in 1927. A notable feature of the industry during 1928 was the tendency toward consolidation of companies into groups under single control. The report discusses the varieties of feldspar, its occurrence, lack of uniformity, improved technical control, uses, specifications, mining and milling methods, industry by states, and imports. R.A.H.

Pennsylvania Geologic Bureau. GEO. H. ASHLEY. *Pit and Quarry*, **19** [5], 67 (1930).—A., state geologist, in a statement reviewed the work of the topographic and geologic survey bureau in the Department of Internal Affairs in the ten-year period during which it has been functioning. E.P.R.

Cambrian "blue" clay. P. A. ZEMIATCHENSKY. *Trans. Ceram. Research Inst.* [Moscow], **23,** 32 pp. (1929).—Z. analyzed the cambrian "blue" clay near Leningrad (U.S.S.R.) to determine the composition of the clays, their structure, and their petrographical character, the latter test being made both by microscope and by a method of treating with hydrochloric acid (10%), precipitating the SiO_2 with a soda solution (5%), then using a NaOH solution. The results showed that (1) the cambrian "blue" clay does not contain hydrated aluminium silicates. (2) The characteristic properties of this clay depend on the fineness of the particles and their mineralogical nature. (3) The particles which compose the cambrian clay are mainly feldspar and chlorite-like minerals, some mica and fine-grained quartz. Other minerals as pyrite, dolomite, etc., are in such small quantities that they have no effect on the properties of the clay. (4) The presence of a considerable quantity of chlorite and feldspar minerals, instead of hydrated aluminium silicates, is a characteristic property of this clay. (5) The large quantity of soluble salts must have a certain influence on the development of ceramic properties of the blue clay. (6) The cambrian clay has a high degree of dispersion and contains a large quantity of particles which approach the colloidal in size. (7) The exceptional fusibility of cambrian clays depends on: (*a*) the great dispersion of the particles and (*b*) their mineralogical character, neither the chlorite nor the feldspar particles being especially refractory. M.V.K.

Essential minerals. A. H. HUBBELL. *Eng. Mining Jour.*, **129** [6], 298–300; [7], 341–42; [8], 405–406 (1930).—An economic discussion. E.C.C.

BOOKS AND BULLETINS

Mineralogy. An Introduction to the Scientific Study of Minerals. HENRY A. MIERS. *Ind. Eng. Chem.*, **22,** 303 (1930); see also *Ceram. Abs.*, **9** [5], 381 (1930). R.G.M.

Diatomaceous Earth. ROBERT CALVERT. *Pit and Quarry*, **19** [13], 89 (1930); for abstract see *Ceram. Abs.*, **9** [5], 381 (1930). E.P.R.

Useful Rocks of Germany and Their Deposits with the Exception of Coal, Ores, and Salts. (Die nutzbaren Gesteine Deutschlands und ihre Lagerstätten, mit Ausnahme der Kohlen, Erze, und Salse). W. DIENEMANN AND O. BURRE. 486 pp. 45 illustrations. Published by F. Enke, Stuttgart, 1929. 33 M. *Z. angew. Chem.*, **43** [14], 298 (1930).—In this second volume by Dienemann and Burre is outlined the occurrence of the technically useful rocks of Germany. They are classified from a petrographic and geographic viewpoint. Intrusive, sedimentary, and metamorphosed rock are treated in order. A review of the properties of the various rock as they have been determined experimentally is included. Their uses in chemical industry are also tabulated; thus the use of silicates and carbonates in the glass and cement industries is given. The short chapter on the German tertiary quartzites which are used in the refractory industry is valuable. The book is comprehensive and well illustrated with tables. A good review of the literature is included. L.T.B.

Materials for the Study of Ukraine Kaolins; Requirements, Methods of Testing, and Industrial Value. (Materialien zur Erforschung ukrainischer Kaoline. Normenbestrebungen, Prüfungsmethoden und industrieller Wert). B. S. LYSSIN AND E. A. GALABUTSKAJA. Kiev Division of the Ukraine Institute for Silica Industries. 406 pp. 4R. *Feuerfest*, **6** [2], 29 (1930).—The authors maintain that the Ukraine kaolins are of great industrial importance and very uniform in composition. The kaolins studied are classified according to their industrial value. It is believed that these kaolins may equal, if not surpass, the Zettlitz deposits in quality and value. L.T.B.

Engineering Geology (Ingenieur geologie). K. A. REDLICH, K. V. TERZAGHI, AND D. R. KAMPE. Julius Springer, Vienna. Price 57M. Reviewed in *Engineering*, **129** [3343], 162 (1930).—A standard work of reference on geology as applied to engineering. A.A.

World reserves and resources of tin. CHAS. W. MERRILL. Bur. Mines, *Information Circ.*, No. 6249, 8 pp. (1930).—Tin has become more and more indispensable to American industry in recent years. The reserves of tin appear to be sufficient to supply the world's tin requirements for many years, provided these reserves are exploited and used with care. Every effort is made to stimulate substitution when economically possible, and recovery of secondary tin is carried on with care and thoroughness. A table is given of world production which represents reserves covering only about a quarter of that produced. Discussion of reserves of the principal tin-mining countries is included. R.A.H.

Geophysical abstracts. XII. FREDERIC W. LEE. Bur. Mines, *Information Circ.*, No. 6287, 33 pp. (1930).—A continuation of asbtracts of current world's literature on geophysical methods of prospecting. For Part XI see *Ceram. Abs.*, **9** [6], 467 (1930). R.A.H.

Ceramic properties of clays from Tschassoff-Jar. K. KÖHLER. *Trans. Ceram. Research Inst.* [Moscow], **20**, 62 pp. (1929).—Different specimens of clays from Tschassoff-Jar (U.S.S.R.) were tested to determine their ceramic properties: (1) plasticity according to Brongniart's method, (2) binding properties, (3) shrinkage from drying and total shrinkage at eleven different temperatures, (4) porosity and its character, and (5) refractoriness. Price 4R. M.V.K.

Composition of the clay from Tschassoff-Jar. WOLD. ISKÜLL. *Trans. Ceram. Research Inst.*, [Moscow], **20**, 57 pp. (1929).—The mineralogical and chemical composition and the mechanical analysis of the clays from Tschassoff-Jar (U.S.S.R.) are given by I. M.V.K.

Phosphate rock. Part I. General Information. BERTRAND L. JOHNSON. Bur.

Mines, *Information Circ.*, No. 6256, 64 pp. (1930).—The report covers the following: definition of phosphate rock, description, origin of deposits, deposits in the U.S., prospecting, mining, treatment, uses, world production and consumption, imports, exports, and prices. Selected lists of references are given together with list of consumers.

R.A.H.

Chemistry and Physics

Determination of silica in the presence of fluorspar. W. T. SCHRENK AND W. H. ODE. *Ind. Eng. Chem. Anal. Ed.*, **1**, 201 (1929); *Sprechsaal*, **63** [13], 230 (1930).—Of the known methods for determining SiO_2 in the presence of fluorspar only the method of Berzelius gives adequate results when fluorspar amounts to more than 1%. The present method, based on the investigations of Jannach and Weber, is that by decomposing with B_2O_3 above an oxygen-blast flame no loss of SiO_2 takes place (here fluorine volatilizes as boron fluoride) and on the researches of Meulen that CaF_2 can be decomposed by the presence of B_2O_3 with H_2SO_4 without corrosion of glass as the uncombined H_2F_2 and B_2O_3 change into BF_3. The results are still better when CaF_2 is decomposed by $HClO_4$ in the presence of B_2O_3, as $Ca(ClO_4)_2$ is easily soluble and therefore can be more easily separated from the residue than $CaSO_4$. The presence of B_2O_3 is absolutely necessary, as otherwise the values found would be too low owing to a loss of SiO_2. The SiO_2 was determined as follows: 0.5 g. finely ground fluorspar is digested in a Pyrex glass beaker with 15 cc. 20% $HClO_4$ saturated with B_2O_3 at 50°C, until 4 or 5 minutes after the first appearance of the white fume of perchloric acid. Then several cc. of H_2O are added and the evaporation repeated for 4 or 5 minutes. The residue is diluted to 50 to 75 cc., the solution heated and SiO_2 filtered, washed with a diluted solution of $HClO_4$ and then with hot water until ammonium oxalate forms no precipitate with the wash water. The filter and the residue are ashed in a platinum crucible, two drops of concentrated H_2SO_4 added and then heated to redness to constant weight. As a corrective proof for the silicic acid found, it is evaporated with H_2F_2 and H_2SO_4. Control tests with chemically pure CaF_2 and SiO_2 (from 1 to 12% of SiO_2 were mixed) showed a maximum error of $\pm$ 0.05% SiO_2.

M.V.K.

Symbols for heat and thermodynamics. ANON. *Mech. Eng.*, **52** [5], 554–55 (1930).—The proposed American tentative standard symbols for heat and thermodynamics are prepared by a subcommittee of the A.S.M.E. and are published for a critical review.

H.W.A.

Determination of fluorine in minerals and rocks. H. LEITMEIER AND F. FEIGL. *Mineralog. petrog. Mitt.*, **40** [1 and 2], 6–19 (1929).—Disadvantages are given of testing for fluorine by the following usual methods: (1) etching glass when the mineral containing F is decomposed by fusion with $KHSO_4$, and (2) the color change produced on the dye from Brazil wood. Two new methods are described. In one the characteristic violet color of zirconium-alizarin solution is changed to yellow in the presence of fluorine. The alizarin solution is prepared by dissolving 0.05 g. zirconium nitrate in 50 g. distilled water and adding 10 cc. concentrated HCl, then mixing with a soltion of 0.05 g. sodium alizarin sulphate in 50 cc. of water. The finely pulverized substance to be tested is treated with 2 or 3 drops of the zirconium-alizarin solution. Fluorite and cryolite react unusually well but silicates require fusion with sodium carbonate. Aluminium phosphate containing F must also be fused. The alizarin method is simple and quick to apply. In the second, or silicofluoride method, advantage is taken of a procedure devised by the authors for determining silicic acid by complex molybdate reaction. A fluoride is treated with H_2SO_4, the HF liberated reacts with powdered quartz to give SiF_4 which with water yields silicic acid and H_2SiF_6. The necessary reagents are, (1) a nitric acid solution of ammonium molybdate, (2) benzidine solution,

(3) saturated oxalic acid solution, and (4) sodium or potassium acetate solution. The finely powdered mineral is mixed with 2 to 4 times its weight of coarsely ground quartz (tested for fluorine) in a platinum crucible. The crucible is set in a wider and shallower crucible and a few drops of concentrated H_2SO_4 are added. The crucible is covered with a watch glass on the under side of which is a drop of water. A small flame is applied to the crucible till white fumes of H_2SO_4 are evolved. After cautiously heating for about 3 min. the flame is removed, and the crucible allowed to cool. The drop on the watch-glass is transferred to a test tube with a small amount of water. A drop of the molybdate solution is added, the mixture heated to boiling, then cooled, a drop of the benzidine solution and sodium acetate solution equal in volume to that of the mixture in the test tube are added. A blue color indicates the presence of fluorine. Minerals not decomposed by hot H_2SO_4 must be fused with sodium carbonate. The method was successfully tested with a number of minerals known to contain fluorine. G.R.S.

Volumetric determination of fluorine by use of ferric chloride. JOHN G. FAIRCHILD. U. S. Geol. Surv., *Jour. Wash. Acad. Sci.*, **20** [8], 141–46 (1930).—A detailed study of the conditions that must be followed in the volumetric determination of fluorine has been made. Suitable conditions are recommended for quantities of fluorine ranging from 0.005 to 0.060 g., which range may probably be extended in both directions. Nearly perfect extraction of fluorine in phosphate rock has been accomplished by the aid of aluminium silicate, by fine grinding, and by removing the calcium carbonate before adding ammonium carbonate. Phosphoric acid is removed as zinc phosphate thus preventing the formation of insoluble ferric phosphate with the ferric chloride. E.C.C.

Zirconium. V. Detection of traces of potassium in presence of zirconium. R. D. REED AND J. R. WITHROW. *Jour. Amer. Chem. Soc.*, **51** [11], 3238–41 (1929).—The use of phosphates to remove zirconium prior to testing for potassium by sodium cobaltic nitrite is not advisable because of loss or dilution of potassium. When phosphoric acid is neutralized with sodium hydroxide and the solution tested with sodium cobaltic nitrite, a misleading precipitate is secured unless a considerable excess of acetic acid is added. Zirconium can be removed by ammonium hydroxide and potassium detected in the filtrate by sodium cobaltic nitrite, after eliminating the ammonium. The best and shortest way of eliminating zirconium prior to testing for potassium by sodium cobaltic nitrite is by throwing the zirconium into a complex ion with tartaric acid and controlling the acidity with sodium hydroxide and acetic acid. For Part IV see *Ceram. Abs.*, **8** [12], 925 (1929). R.G.M.

Reduction reactions with calcium hydride. I. Rapid determination of sulphur in insoluble sulphates. W. E. CALDWELL AND F. C. DRANSKOPF. *Jour. Amer. Chem. Soc.*, **51** [10], 2936–42 (1929).—Calcium carbide was not as effective as calcium hydride. Calcium hydride is suitable for quantitative reduction of alkaline earth and alkali sulphates to sulphides, the residual sulphur being determined by iodine titration. An example is given of replacement of potassium and sodium by calcium. R.G.M.

Ceric sulphate as a volumetric oxidizing agent. X. Determination of thallium. H. H. WILLARD AND PHILENA YOUNG. *Jour. Amer. Chem. Soc.*, **52** [1], 36–42 (1930). **XI. Oxidation of organic acids.** *Jour. Amer. Chem. Soc.*, **52** [1], 132–42 (1930); for previous abstracts see *Ceram. Abs.*, **9** [2], 132–33 (1930). R.G.M.

Convenient method for gravimetric determination of aluminium as oxide. R. FRICKE AND K. MEYRING. *Z. anorg. allgem. Chem.*, **188** [1], 127–37 (1930).—A method is given by which aluminium is precipitated from an alkali solution with carbon dioxide and determined as Al_2O_3. L.T.B.

An oxidimetric determination of PO_4 ions. LEOPOLD BRESTAK AND ORVILLE A.

DAFERT. *Z. angew. Chem.*, **43** [10], 216 (1930).—Description of a method for the determination of PO_4 ions by the use of nascent sulphurous acid for the reduction of the phosphor-molybdic acid. The advantages claimed over the old method are simplicity and rapidity. L.T.B.

Quantitative determination of sulphates in the presence of aluminium fluorides. H. GINSBERG. *Z. angew. Chem.*, **43** [1], 21–24 (1930).—The usual method for the determination of sulphates in the presence of fluorides is to reduce them to sulphides by the use of zinc dust and then determine the sulphur as hydrogen sulphide. The results obtained by this method are not quantitative but a modification is proposed to make them so. L.T.B.

Reliability of the sulphur dioxide determination according to the Reich-Raschig method. H. E. WOISIN. *Z. angew. Chem.*, **43** [14], 293–94 (1930).—The Reich-Raschig method for determining SO_2 in gases consists in passing the gas through an iodine-starch solution and noting the amount required to decolorize the solution. W. shows the error one may expect if there are nitrogen oxides in the gas. L.T.B.

Size distribution of finely-ground powders. ANON. *Queensland Govt. Mining Jour.*, **30** [8], 391 (1929).—The determination of the size distribution of very finely-ground powders is of considerable importance in the solution of problems connected with the properties of Portland cements, of clays for ceramic purposes, pigments, etc. Heretofore no satisfactory method has been available for the dry separation of finely-powdered materials into sizes below 20 to 30 microns (one micron = $^1/_{25,000}$ of 1 in.). In connection with research on the utilization of anhydrite for retardation of Portland cement an air analyzer for fine powders has been developed. E.P.R.

Analysis of raw phosphates. A. SUCHIER. *Z. angew. Chem.*, **43** [15], 313–14 (1930).—Method for the analysis of raw phosphates with a P_2O_5 content of more than 25%. L.T.B.

Oxidation of selenium dioxide and of tellurium dioxide with lead dioxide. F. C. MATHERS AND F. V. GRAHAM. *Jour. Amer. Chem. Soc.*, **51** [11], 3225–28 (1929). R.G.M.

Hydrogen-ion measurement with glass electrode and vacuum tube potentiometer. L. W. ELDER, JR. *Jour. Amer. Chem. Soc.*, **41** [11], 3266–72 (1929). R.G.M.

Determination of the moisture content of coal. MANFRED MANNHEIMER. *Colliery Guardian*, **140** [3605], 426 (1930).—A new method for the determination of the moisture content of coal, etc., which permits an analysis of moisture within 5 minutes consists in the extraction of the coal by a hygroscopic liquid and subsequent determination of the water content of this liquid. Methanol approaches most closely the ideal of the liquids which have been considered. For determining the moisture content of the methanol the following methods were tried: electrical conductivity of dilute salt or acid solutions in methanol; change of critical solution temperature of hydrocarbons; catalysis constant of a dissolved ester; determination of density. The last method is the most convenient one and a method was worked out which can generally be used for measuring changes of density as small as 0.01% in any liquid. The method is described in detail. E.J.V.

Transformation of cristobalite into tridymite in an Na_2O–CaO–SiO_2 batch. H. JEBSEN-MARWEDEL AND A. BLECKER. *Sprechsaal*, **63** [15], 268–70 (1930).—The process of the transformation of tridymite from cristobalite according to the principle of stages by Oswald was observed. If the batch is supersaturated with SiO_2 the silicic acid appears at first in the form of cristobalite which changes more or less quickly into tridymite. The observations were made with a microscope and photographed; fifteen photos show the phases of the transformation of crystobalite into tridymite. M.V.K.

Influence of high temperatures on kaolin. V. V. IOURGANOV AND M. V. ZOUSMANOVICH. *Trans. Ceram. Research Inst.* [Moscow], **21**, 29 pp. (1929).—The method of fractional chemical treatment was used and the reagents were KOH and HF. The results obtained showed (1) at 880°C there is no noticeable change. (2) At 980°C there is a disintegration of kaolinite into silica and a difficultly soluble form of alumina. (3) At 1050 to 1100° the general appearance changes little. Sillimanite could not be detected. (4) At 1200° the difficultly soluble residue increases. Its composition can be expressed by the formula $5Al_2O_3 \cdot 4SiO_2$. (5) At 1320° appears the proportion $Al_2O_3:SiO_2$ 2.70:2, which closely resembles the compound $4Al_2O_3 \cdot 3SiO_2$. (6) At 1400° a certain quantity of crystals can be discerned. The composition of the product formed lies between that of natural and theoretical mullite. (7) At 1470° the formation of crystals increases. (8) The test of the total series of difficultly soluble residues showed that the alumina content increases with an increase of temperature and at 1400° or higher the ratio of $Al_2O_3:SiO_2$ approaches 3:2. M.V.K.

How alumina affects slags in steel melting furnaces. ANON. *Iron Age*, **125** [12], 845 (1930).—The dephosphorization of steel in the electric furnace with aluminous slags is more difficult to carry out than it is with pure lime slags while in the open-hearth furnace it is practically impossible to dephosphorize with aluminous slags. The desulphurization of steel with aluminous slag is impracticable but in the electric furnace iron-carbon alloys and sulphide of iron can be desulphurized with lime alumina mixtures and also with pure alumina. As a deoxidizer, aluminium behaves exactly in the same way as silicon but it has the great advantage that its oxide is not as strong an acid as silica and can therefore be used in a more highly concentrated form than silicon even in the basic electric furnace without adversely affecting the desulphurization and without attacking the furnace lining. E.C.C.

Ferric alumina. A. R. MOBERG AND E. M. PARTRIDGE. *Ind. Eng. Chem.*, **22** [2], 163–64 (1930).—The material which has been named ferric alumina is essentially a colloidal sol of hydrous alumina peptized by the addition of ferric chloride. It is used for coagulation purposes. R.G.M.

γ-Al_2O_3 and spinels. WILHELM BILTZ AND ALFRED LEMKE. *Z. anorg. allgem. Chem.*, **186** [3], 373–86 (1930).—A series of density and molecular volume determinations on the forms of alumina and a series of spinels showed that the spinels contain γ-alumina as such. γ-alumina changes to the α-modification between 750°C and 1000°C. It is monotropic with respect to the α- form. Its density varies somewhat but its lowest value is 3.42. L.T.B.

High-temperature equilibrium between silicon nitride, silicon, and nitrogen. W. B. HINCKE AND L. R. BRANTLEY. *Jour. Amer. Chem. Soc.*, **52** [1], 48–52 (1930). R.G.M.

Molecular structure of the tungstosilicates and related compounds. LINUS PAULING. *Jour. Amer. Chem. Soc.*, **51** [10], 2868–80 (1929). R.G.M.

System Al_2O_3–H_2O. G. F. HÜTTIG AND O. KOSTELITZ. *Z. anorg. allgem. Chem.*, **187** [1], 1–15 (1930).—When freshly precipitated in the cold, aluminium oxide hydrate is amorphous and contains one molecule of water which is given off gradually on heating as is characteristic of colloids. The amorphous form is not stable at room temperatures but changes on aging to a series of crystalline hydrates varying in composition from $Al_2O_3 \cdot H_2O$ to $Al_2O_3 \cdot 3H_2O$. Aging was studied with X-rays and resulted in a continuous displacement of the position and intensity of the lines. L.T.B.

System cobalt oxide–water. GUSTAV F. HÜTTIG AND ROBERT KASSLER. *Z. anorg. allgem. Chem.*, **187** [1], 16–23 (1930).—Dehydration curves and X-ray studies showed that one compound, $CoO \cdot H_2O$, exists in the system. L.T.B.

Yellow iron oxide hydrate and its relation to rust and iron ores. V. RODT. *Natur-*

wissenschaften, **18** [10], 230–31 (1930).—Yellow iron oxide hydrate is a fine yellow material which differs from the ordinary brown voluminous precipitate. On drying the yellow hydroxide at 180 °C, it has a composition $Fe_2O_3 \cdot H_2O$ which occurs in two modifications, α and γ, according to the method of preparation. The α-form occurs in rust in small amounts and in most iron ores. The γ-form usually occurs when prepared artificially and in some minerals, notably lepidolite. On heating the γ-modification at 200 °C it changes to a magnetic Fe_2O_3; similar treatment of the α- modification does not form the magnetic oxide. A list of references to these two forms is included.

L.T.B.

Feldspar uses in ceramic industries. ANON. *Pit and Quarry*, **20** [3], 47 (1930).—The chief use of feldspar is as a constituent of both body and glaze in pottery, porcelain, white ware, vitrified sanitary ware, and enameled brick. Feldspar constitutes 10 to 35% of the body of vitrified ware, in which it acts as a flux to bind the particles together. Glazes contain 30 to 50% of feldspar. E.P.R.

Significance of the word "eutectic." C. N. FENNER. *Jour. Geol.*, **38** [2], 159–65 (1930).—"Eutectic" has been used in varying ways with the result of some confusion. If the word is broadened to apply to other relations, such as ternary eutectic curves and surfaces, then a new word is needed to apply to the original condition for which "eutectic" was originally invented. As now used by some writers it means little more than separation of crystals from a solution and hence has no special significance. For this process the terms "boundary curves" and "boundary surfaces" express the idea simply and adequately. With the extension of meaning to crystallization along a boundary curve, there has been a tendency to assume that the product still possesses attributes found to hold for the unique condition when "eutectic" was used to refer only to a point. This tendency is shown in two ways: (1) correspondence of heat of solution to heat of fusion may hold for two, three, or even four component systems; (2) graphic structures in rocks assumed to be of eutectic origin, since this peculiar structure is not infrequently shown when two or more substances (metals especially) simultaneously crystallize at a eutectic point. It seems desirable to return to the early significance of the word: that "eutectic" implies a certain point on a crystallization diagram. G.R.S.

Behavior of metal oxides and silicates in a chlorine stream. ROLAND WASMUHT. *Z. angew. Chem.*, **43** [5], 98–101; [6], 125–29 (1930).—Studies on the attack and decomposition of various refractories by chlorine at high temperatures, 200 to 1100 °C, in the presence of small amounts of carbon, phosphorous, and sulphur. L.T.B.

Studies on thermochemistry of compounds occurring in the system CaO–Al_2O_3-SiO_2. II. Heat of solution of calcium hydroxide in HCl 200 H_2O. T. THORVALDSON AND W. G. BROWN. *Jour. Amer. Chem. Soc.*, **52** [1], 80–87 (1930); for Part I see *Ceram. Abs.*, **9** [5], 331 (1930). R.G.M.

Precipitated selenium dioxide. G. F. HOFFMANN AND V. LENHER. *Jour. Amer. Chem. Soc.*, **51** [11], 3177–84 (1929).—The authors were unable to prepare selenium trioxide by the method of Worsley and Baker. The product of ozone oxidation of Se-$SeOCl_2$ solution was identified by analyses as precipitated selenium dioxide. The density of precipitated selenium dioxide was found to be appreciably lower than that of the sublimed dioxide. The precipitated oxide absorbs moisture rapidly to form selenious acid. The molecular weights of precipitated and sublimed SeO_2 dissolved in $SeOCl_2$ were found to be identical. The product of ozone oxidation of Se-$SeOCl_2$ solutions absorbs dry hydrogen chloride gas to form a fuming, straw-colored liquid similar in composition and density to selenium hydroxy-chloride and not chloroselenic acid. R.G.M.

Beryllium. STOCK. *Queensland Govt. Mining Jour.*, **30** [8], 396 (1929).—At the

annual conference of the Vereins Deutscher Chemiker, S. stated that metallic beryllium was discovered almost at the same time as aluminium and magnesium in 1828. Wöhler obtained the metal through the reduction of beryllium chloride with metallic potassium, as a fine powder. The Stock-Goldschmidt process, which consisted of the electrolysis of the double fluoride of beryllium and barium, or of beryllium and sodium, was developed and improved by the Siemens-Halske A.-G. The new Stock-Goldschmidt or Siemens-Halske process employed beryllium oxyfluoride mixed with barium fluoride as the electrolyte. An experimental plant of a capacity of producing about a ton of beryllium metal yearly is now under construction and will come into operation during the current summer. E.P.R.

Flotation research on the relative activity of the various constituents of crude cresylic acid. GEORGE L. LANDOLT, E. G. HILL, AND ALEXANDER LOWY. *Eng. Mining Jour.*, **129** [7], 351–52 (1930). E.C.C.

Contraction of kaolin and clays on drying. ANON. *Corriere ceram.*, **11** [1], 35 (1930).—The linear contraction and loss of water during drying were measured. In pastes a part of the water is taken up by the colloidal substances and swells them, while another part, the interfacial water, fills the empty spaces between the particles. The colloidal water must be evaporated slowly to prevent warping. When contraction ceases the rate of drying can be increased. Quartz, talc, and feldspar in a paste did not contract on drying. Kaolins, clays, and bauxites contract and harden on drying; they have a colloidal plasticity which is developed only in the presence of water. Experiments are described which were made on pastes of kaolin at different temperatures and pressures. The free silica had to take the place of a certain number of colloidal particles and neutral particles. This rendered the material less plastic and less porous. The plasticity can be expressed in figures, dividing the weight of the colloidal water by the weight of the total water absorbed and multiplying the quotient by the contraction. Increasing temperature and pressure decreases the colloidal and interfacial water. The diminution from the interfacial water is small in relation to the variation from the colloidal water. M.V.K.

Pipette method of mechanical analysis of soils based on improved dispersion procedure. L. B. OHMSTEAD, L. T. ALEXANDER, AND H. E. MIDDLETON. *Chem. News*, **140** [3645], 114–18 (1930).—A brief comparison is made of mechanical soil analysis by elutriation, Osborne beaker, and centrifuge methods. When the pipette method was introduced more stable and complete dispersion was required than in the centrifuge methods, resulting in the adoption of the practical and international methods. These methods, one intended to give partial, the other complete dispersion, represent two diverse purposes of mechanical analysis. In the practical method endeavor is made to avoid removing coatings from grains or breaking up slightly cemented particles. In the complete dispersion or international methods colloidal coatings on sand and silt grains are removed, aggregates are separated into single grains or groups smaller than 2 equivalent diameters. The chemical and mechanical aids to dispersion considered are treatment with (1) H_2O_2, (2) HCl, (3) water, and (4) dispersing agents, *i.e.*, ammonium hydroxide, sodium hydroxide, sodium carbonate, and sodium oxalate, electrolysis, and shaking. Treatment with 0.2 *N* HCl is not always effective in removing carbonates and in some cases presents a distorted picture of the soil. When ammonia is used CO_2 is absorbed from the air giving an uncertain increase in weight. The use of sodium oxalate causes this difficulty to disappear. Unlike the hydroxides, sodium oxalate frees no alkaline earth hydroxides as a result of chemical equilibriums established. For soils not having had the acid pre-treatment, sodium and ammonium hydroxides are not suitable deflocculents. Effective dispersion by electrolysis, using the Mattson cell removes carbonates, "exchange bases," chlorides, sulphates, and phosphates. No

foreign ion is introduced by this method, hence no washing is required afterward. Disadvantages are (1) requirement of considerable extra equipment, (2) extra time, (3) additional transfers of the sample with attendant possibilities of loss, and (4) where determination of exchangeable bases is not desired, yields no results that cannot more easily be obtained by acid treatment. G.R.S.

Plasticity of clay. L. E. JENKS. *Jour. Phys. Chem.*, **33** [11], 1733–57 (1929).—The object is to determine what salt or salts will keep an alumina-rich or a silica-rich gelatinous film on a clay grain in such a state that it will take up water again and become gelatinous after having been dried moderately. Experiments were made on gelatinous alumina, gelatinous silica, and mixtures of the two. Six clays were also tested. After devising a plasticity test, the mechanism of the test was studied. In determining the effect of added electrolytes on the plasticity of clay, use was made of the common salts of all the alkali and alkaline earth metals usually reported in an analysis of a clay. Lithium salts were also included. The effect on the plasticity of clay of the action of a flocculating material in a peptizing medium as an explanation of the cause of plasticity of clay was investigated. Kaolin and bond clays were found to be made more plastic through a combined peptizing and flocculating action. To determine the presence or absence of plasticity of clay in a gelatinous alumina and a gelatinous silica to which lithium salt had been added, five criterias were formulated. They were used in studying the effect on gelatinous alumina and gelatinous silica of combined peptizing and flocculating materials. Results indicate (1) the cause of plasticity of clay is the formation in the moistened clay of a continuous gelatinous external phase through the action of water in making gelatinous the material that forms an enveloping surface around the nongelatinous particles and aggregates present in the clay. (2) Plasticity of clay is not a property of a clay slip unless the gelatinous envelopes surrounding the nongelatinous particles and aggregates form a continuous external phase and the nongelatinous particles and aggregates form the dispersed phase. Where the continuous external phase is a liquid and the dispersed phase is made up of particles and aggregates the surface of which is formed by a gelatinous envelope, the material has the property of viscosity. It does not have the property of plasticity of clay. (3) The material that is capable of becoming gelatinous when it is moistened is maintained by a simultaneous peptizing and flocculation action which preserves the gelatinous envelope and hinders or prevents the change of its material into something that will not take up water and become gelatinous when moistened. (4) The presence of organic matter, of dissolved carbon dioxide, or of electrolytes in the supernatant water or in the clay itself is not the cause of plasticity of clay. Such materials are agents through the action of which a sufficient amount of material capable of becoming gelatinous when moistened is formed and once having been formed, by any agent, is preserved. (5) The relative plasticity of clay may be evaluated by the time taken for the continuous external phase formed by the cohering gelatinous envelopes to be replaced through the formation of a continuous external liquid phase dispersing as the internal phase separated particles and aggregates each enveloped with gelatinous material. (6) Two methods are given for the measurement of the relative plasticity of clay: (*a*) using the air-dried material that had been wet to its highest plasticity as determined under the thumb; (*b*) using the material while plastic. The relative plasticity of some commercial bond clays as obtained by both methods is given. (7) The relative plasticity of clay obtained through the testing of the material that had been air-dried, after it had been moistened to its highest plasticity, is used in this paper as it seems to give results more in agreement with accepted relative plasticities of commercial bond clays than the alternate method. This test is as follows: a small amount of the material in a fine state of division is moistened to its highest plasticity, as determined under the

thumb, and molded in the palm of the hand to a test-ball which is allowed to dry undisturbed in the air 16 to 24 hours. This test-ball is then so placed in an excess of water that the spalled particles may fall away from the disintegrating test-ball. The time in minutes required for the wasting away of the test-ball is recorded as the relative plasticity of clay for that material. (8) A dilute solution of sodium hydroxide peptizes alumina, but not all the alumina present in the solution is so held, as the addition of sodium chloride will not flocculate all the compounds of alumina in the liquid. The ratio of the amount held peptized to the total amount present was greater when $N/9$ sodium hydroxide acted upon amalgamated aluminum than when $N/20$ solution was used. (9) Gelatinous alumina and also gelatinous silica were made into a plastic material. (10) The criterions established to determine when a material had plasticity of clay were as follows: (*a*) The powdered material when moistened to plasticity of clay must have the characteristic feel of a plastic clay. (*b*) The air-drying of the plastic mass must not give a cemented aggregate. (*c*) Repeated alternate moistening to plasticity of clay and moderate drying must not remove the properties of bonding and of mobility when the material is remoistened to plasticity of clay. (*d*) When the material is made into a dilute slip and the supernatant liquid decanted from the well-settled sludge, redrying and remoistening to plasticity must not give a nonplastic mass. (*e*) The material, which has been molded into a test-ball, when moistened to plasticity of clay and then dried in the air, must not spall away at once like a finely-ground sand when placed under water, but it should form a mass that may be readily worked into a plastic mass or a surface layer of plastic material on the test-ball or the entire undisturbed mass will become more plastic. (11) The constituent material of a clay and its structure are important only as far as kind of material and fissility may aid in the formation of a gelatinous material around the nongelatinous particles and aggregates. (12) In actual clays the effect of humus must also be considered. G.R.S.

Influence of different additions to fluidity of thick slips. KARL BIEHL. *Tonind.-Ztg.*, **54** [23], 496–97 (1930).—The influence of fluidity agents as the salts gypsum 1%, soda 1%, Na_2O_2 0.25%, and also sulphite waste liquor 1%, were tested on thick slips. The salts greatly increased the fluidity of raw slips of clay and lime. Slips of marly limestone were much less affected, if at all, by the salts, while the sulphite waste liquor greatly increased their fluidity. M.V.K.

Flow of clay pastes through narrow tubes. G. W. SCOTT BLAIR AND E. M. CROWTHER. *Jour. Phys. Chem.*, **33** [3], 321–30 (1929).—The authors propose to give (1) quantitative evidence to show that an equation only slightly modified from that of Buckingham holds under certain conditions of shear; and (2) qualitative evidence in favor of the Buckingham theory for those regions where quantitative measurements have not been practicable. Experiments on the behavior of certain clays were made in a modified Bingham plastometer. In this apparatus there were two bulbs, the clay being sheared alternately from one to the other. The level of clay in the two bulbs was kept the same so that no correction was required for hydrostatic head. Applied pressures varied from 0.05 to 50 cm. of mercury, and rates of flow from 0.0002 to 2.0 $cm.^3$ per sec. The results show that (1) the flow curves fall into four stages. In the first stage there is no flow; in the second the value of dV/dP is constant; in the third it increases rapidly, and in the fourth it is again constant. The movements are successively plug flow, plug flow with streamline flow in an outer sheath, and entirely streamline flow. (2) This behavior is shown qualitatively by experiments with dyed clays and for the most part quantitatively from the constancy of the plastometric functions to agree with an equation slightly modified from Buckingham's theoretical equation. (3) It is found as an experimental fact that the ratio of the constants derived from the slopes of the plug and streamline stages respectively is constant over a wide range of

concentration for a single clay. For clays of widely different geological origin variations in the ratio are small, but probably significant. G.R.S.

Viscosity of aqueous solutions of strong electrolytes with special reference to barium chloride. G. JONES AND M. DOLE. *Jour. Amer. Chem. Soc.*, **51** [10], 2950–64 (1929). R.G.M.

Notes on formulation. ROBERT C. H. HECK. *Mech. Eng.*, **52** [2], 133–39 (1930).—This paper presents two matters: (1) an investigation of the pressure-volume form of the adiabatic of steam leading to a general comparison of formulations; (2) a discussion of the thermal properties of the liquid, along and behind the saturation line. H.W.A.

Specific heats of gases at high pressures. I. Method and apparatus at room temperature. N. W. KRASE AND B. H. MACKEY. *Jour. Amer. Chem. Soc.*, **52** [1], 108–15 (1930).—A constant temperature continuous flow adiabatic calorimeter is described. The apparatus for measurement of the specific heats of gases at ordinary temperatures and up to 1000 atmospheric pressure is described. Typical results for nitrogen at 200 atmospheres are given together with the method of calculation. R.G.M.

General formulas for the calculation of atomic or molecular heats as well as specific heats of the elements and their compounds in the solid states. I. MAYDEL. *Z. anorg. allgem. Chem.*, **186** [3], 289–323 (1930). L.T.B.

Automatic analyzers for gaseous mixtures based on the thermal conductivity of the gases. PAUL JARRIER. *Chaleur ind.*, **11**, 181–85 (1930).—J. explains the theory and applications. A.J.M.

Compressed air chart. SYDNEY C. MIFFLEN. *Eng. Mining Jour.*, **129** [7], 353 (1930).—A chart based on D'Arcy's formula comparing pressure, air flow, pressure drop, and air delivery in pipes. E.C.C.

Vapor pressure of water from the ice point to the critical point. F. G. KEYES AND L. B. SMITH. *Mech. Eng.*, **52** [2], 124–27 (1930). H.W.A.

Report on progress in steam research at the Bureau of Standards, with determinations of heat content and latent heat up to 270°C. N. S. OSBORNE, H. F. STIMSON, AND E. F. FIOCK. *Mech. Eng.*, **52** [2], 127–30 (1930). H.W.A.

Pressure consideration and linear translation in steam, air, and gas measurement. H. HOFFMAN. *Die Messtechnik*, **5** [12], 329–34 (1929).—It is shown that the consideration of pressure is as important as linear translation and that neither can be disregarded. As the simplest pressure considerations do not permit any registration other solutions were sought. The best are described and are discussed critically. Their quality depends chiefly on the security of reading in the region of zero. E.J.V.

Physical testing methods for the investigation of sands and clays. FRANZ ROLL. *Die Messtechnik*, **5** [6], 156–60 (1929).—Different methods used in the testing and determination of the properties of clays and sands are described. Next to the strength tests, gas perviousness and density are important. The testing of granulation and heat conductivity are next in importance. A bibliography of 29 references is included. E.J.V.

BOOKS

Old and New Quantum Theories. (L'ancienne et la nouvelle theorie des quanta). EUGENE BLOCH. Published by Hermann, Paris. 447 pp. Reviewed in *Chaleur ind.*, **11**, 211 (1930). A.J.M.

Treatise on General and Experimental Physics. (Traité de physique générale et expérimentale). Vol. I, mechanics, heat. JULES LEMOINE AND AUGUSTE BLANC. Published by Leon Eyralles, Paris. 860 pp. Reviewed in *Chaleur ind.*, **11**, 210 (1930). A.J.M.

Standards Yearbook, 1930. ANON. Compiled by the National Bureau of Standards. 301 pp. (1930).—This book covers broadly the developments in standardization during 1929 all over the world. The current yearbook begins with an article on the Government's interest in advancing standardization and simplification and records gratifying progress in the redetermination of the electrical units on a fundamental basis. Although special attention has been paid to the organization and procedure of the national standardization agencies in the U.S. and abroad, the present volume likewise contains outlines and activities of state, county, and municipal agencies as well as those of technical societies and trade associations. R.A.H.

International Critical Tables of Numerical Data, Physics, Chemistry, and Technology. Vol. VI. E. W. WASHBURN. Prepared under the auspices of the International Research Council and the National Academy of Sciences by the National Research Council of the U.S. 471 pp. McGraw-Hill Book Co., Inc., 1929. To be published in 7 volumes. Price $84 per set on orders per set only; payable at the rate of $12 per volume as issued. Reviewed in *Ind. Eng. Chem.*, **21** [12], 1304 (1929).—The subject matter includes X-rays, electronics, dielectrics, electrical conductivity and resistivity, pyro, piezo, thermo, and atmospheric electricity, e.m.f. of cells, transference numbers, magnetism, and acoustics. R.G.M.

Technical Dictionary. (Techno-Diktionar.) HUBERT HERMANNS. 407 pp. Reviewed in *Chaleur ind.*, **11**, 167 (1930).—This dictionary contains technical terms in German, English, and Italian. A.J.M.

Popular Research Narratives. Tales of Discovery, Invention, and Research. Vol. III. Collected by the ENGINEERING FOUNDATION, INC. 174 pp. Williams & Wilkins Co., Baltimore, 1929. Price $1.00. Reviewed in *Ind. Eng. Chem.*, **21** [11], 1150 (1929).—This book is composed of short scientific stories written to appeal to any reader. They are authoritative and appeal to so wide a variety of interests that they are highly recommended, particularly to those interested in humanizing science. R.G.M.

Select Methods of Metallurgical Analysis. W. A. NAISH AND J. E. CLENNELL. With an introduction by H. C. Harold Carpenter. Pp. xii + 495. Chapman & Hall, London, 1929. 30s. Reviewed in *Engineering*, **129** [3343], 162 (1930).—This is an excellent work, and is likely to establish itself as a standard reference book on its subject. It contains little, if any, original work, but may be regarded primarily as a collection and summary of the most important methods of analysis for those elements met in metallurgical practice, and the methods of analysis described have been selected with care and discretion. Comprehensive bibliographies of analytical methods for each element are given which are likely to be most helpful where extended reference or refinement in analysis is specially called for. The book is divided into six parts. Part I deals with qualitative analysis, sampling, and with the preparation and measurement of samples. Part II, which is the principal section of the work, and extends over about 250 pp., gives full details of methods of analysis for each element and careful directions for the carrying out of the various tests. Part III covers the analysis of commercial metals, non-ferrous alloys, iron and steel, and ferro-alloys. Part IV deals with ores, slags, and other impure materials, and the analysis of coal and refractory materials is described in Part V. Part VI consists of three valuable contributions on electrometric titrations, the analysis of minerals, and spectrographic methods of analysis by C. Stansfield Hitchen, H. F. Harwood, and A. A. Fitch, respectively. The last is particularly interesting in view of the widening applications of the subject. The comprehensive nature of the whole work is apparent from the above summary, and each particular subject is fully covered by the section devoted to it. Thus in Part II, under each element, separate headings include general properties of the element, selected methods of determination, and a bibliography. Taking copper as a single example,

the general properties of the metal and the characteristics of those salts employed in its detection and estimation are described. The methods of analysis cited are as follows: (1) precipitation as sulphide, conversion to nitrate, then to acetate, and titration with potassium iodide and thiosulphate; (2) precipitation from alkaline tartrate solution by hydrazine hydrochloride; (3) precipitation from sulphuric acid solution on zinc or aluminium; (4) titration with potassium cyanide; (5) electrolytic deposition from nitric acid solution; and (6) colorimetrically. The bibliography contains about 130 references to the separation and estimation of the element. An excellent index is provided, which, in a reference book of this nature, is of considerable importance. The book goes, of course, much beyond the needs of the ordinary student, but it is worthy to be in the library of all professional metallurgists, and should be available for reference by all assayers and metallurgical chemists. (*B.C.A.*)

Study of Materials by X-Rays. (Röntgenographische Werkstoffprüfung.) Karl Becker. Vieweg und Sohn, Braunschweig, 1929. 7 M. *Z. angew. Chem.*, **43** [6], 139 (1930).—The book contains a short theoretical discussion of X-rays and crystal structure and a more lengthy description of the application of X-rays in studying the structure of materials with monochromatic and white X-rays. The book is less concerned, however, with the actual determination of structure than with the interpretation which one can draw from the position, intensity, etc., of the lines of the patterns obtained. L.T.B.

1930 Handbook for Ceramics, Glass, and Allied Industries. (Sprechsaal Kalendar 1930 fur Keramik, Glas und verwandte Industrien.) J. Koerner. Reviewed in *Z. angew. Chem.*, **43** [6], 140 (1930); for abstract see *Ceram. Abs.*, **9** [5], 396 (1930). L.T.B.

Influence of 5% soda solution on clay. L. A. Shmeleff. *Trans. Ceram. Research Inst.* [Moscow], **18,** 10 pp. (1929).—The result of the action of 5% soda solutions on clays depends greatly on the partial precipitation of SiO_2 and Al_2O_3 from the soda solution. The SiO_2 and Al_2O_3 precipitated by the soda solution are easily soluble in 1 to 2% hydrochloric acid. Repeated tests on the Gluchov's clay (U.S.S.R.) which is known to contain pure Al_2O_3 lead to the conclusion that this clay contains at least 4% of pure Al_2O_3. M.V.K.

PATENTS

Recovering borax from brine. Henry D. Hellmers. U. S. 1,756,122, April 29, 1930. Method of recovering borax from brine containing borate in solution together with sodium carbonate, which consists in treating the brine with carbonic acid gas to precipitate some of the carbonates, removing the precipitated carbonates from the solution, and crystallizing out the borax by cooling.

Production of titanic oxide. Moritz Schnetka. U. S. 1,758,472, May 13, 1930. (1) In the process for the hydrolytic precipitation of white titanic acid from sulphuric acid solutions containing titanium sulphate and iron sulphate, the step which comprises carrying out the precipitation in the presence of a compound of the group consisting of hydrofluoric acid and water-soluble fluorides. (2) Carrying out the precipitation in the presence of hydrofluoric acid.

Production of titanium dioxide. Werner Mecklenburg. U. S. 1,758,528, May 13, 1930. (1) A process for preparing a seed suspension which comprises reducing the acidity of titanium sulphate solution to a hydrogen-ion concentration of about p_H 2.5 to 6.0, heating the mixture to about 80°C for 15 to 30 minutes, and cooling the mixture. (2) A process for the production of titanium dioxide which comprises adding a mixture containing titanium hydroxide in aqueous suspension containing sodium sulphate to a solution of titanium sulphate, and maintaining the mixture at a temperature near the boiling point. (3) A process for the hydrolysis of titanium sulphate solu-

tion which comprises adding sufficient alkali to a small portion of the solution to reduce the acidity of p_H 2.5 to 6.0 and to precipitate titanium hydroxide therein, heating the mixture to about 80 °C for 15 to 30 minutes, adding the mixture to the rest of the titanium sulphate solution, and maintaining the mixture at a temperature near the boiling point.

Sodium borate tri-sodium phosphate compound. CHARLES F. BOOTH, ARTHUR B. GERBER, AND PAUL LOGUE. U. S. 1,759,152, May 20, 1930. (1) Composition of matter consisting of a compound of sodium phosphate and sodium borate. (2) Process for the manufacture of a sodium borate tri-sodium phosphate composition, which consists in the addition of caustic soda and sodium borate to di-sodium phosphate, substantially as described.

Sodium metaborate. A. KELLY. Brit. 326,378, April 30, 1930. Sodium metaborate is produced by heating in water a boron compound, *e.g.*, crude borax, sodium borate, Tincal, Rasorite, or other mineral, with a determined quantity of sodium carbonate and lime. The solution is filtered and sodium metaborate obtained by crystallization or granulation. The disseminated calcium carbonate assists filtration. In the example given, a charge containing Rasorite is kept agitated at a temperature of about 80 °C for five hours. The solution obtained may be a bright green, in which case it must be bleached with a solution of bleaching powder, or sodium hypochlorite. The mother liquor after crystallization may be incorporated in the next charge. A mixture of Tincal and Rasorite may be employed.

General

Annual report of the Refractories Division Research Committee for 1929. DONALD W. ROSS. *Bull. Amer. Ceram. Soc.*, **9** [5], 158–64 (1930). E.J.V.

Chemical and metallurgical index of prices revised. ANON. *Chem. Met. Eng.*, **37** [1], 66–67 (1930).—A weighted index number for prices of chemicals, fats, and oils has been issued based on production returns and imports for 1927. Results are shown in tables and graphs. G.R.S.

Silicate of soda gains in export trade. ANON. *Chem. Met. Eng.*, **37** [1], 57 (1930).—New uses and larger export demands have made production of silicate of soda surpass the totals of recent years. The greater part of the exports were sent to Canada. G.R.S.

Some peculiar properties of sands. J. E. WORSDALE. *Pit and Quarry*, **18** [12], 48–50 (1929).—Sand is a very peculiar material in its physical behavior since it is intermediate between a solid and a liquid. If ordinary material is compressed in one direction, its volume is reduced; however, with sand the volume is increased instead of decreased. The discoverer of the effect of pressure on the void content of sand was the late Osborne Reynolds, of England, who gave it the name "dilatancy." W. in an address before a British Engineering Society explained the theory underlying dilatancy as follows. If a pile of spheres is built up, it will be found that there are three methods of symmetrical piling which produce different void contents and any other method of piling will give one of the results of these three methods: (1) closest packing 26% voids, (2) intermediate 39.5% voids, and (3) loosest 47.6% voids. The explanation of dilatancy as applied to spherical particles of uniform diameter is described and by analogy the case of ordinary sand particles can be considered to give similar results. E.P.R.

Control of homogeneity. ANON. *Brit. Clayworker*, **38** [455], 455 (1930).—Clay mixture passed through a pug mill or pan mill is not always homogeneous. To ascertain uniform consistency press a lump until it cracks at the edges. Uniformity in chemical composition can be ascertained by analysis or roughly by converting a weighed amount into a slip, screening, and weighing the washed and dried residue on each sieve. A comparison will show whether the material is homogeneous. Drying shrinkage,

porosity of the dried and fired material, and the tensile strength of the paste or dried material may also be used as indicators of homogeneity. Lumps of clay dyed with fuchsine may be passed at $^1/_4$-hr. intervals into the mixing machine. A sliced sample of the mixed product will indicate the thoroughness of mixing. R.A.H.

Drying of solids. III. Mechanism of the drying of pulp and paper. T. K. SHERWOOD. *Ind. Eng. Chem.*, **22** [2], 132–36 (1930).—The drying operation is in general divisible into a constant-rate period and a falling-rate period. During the constant-rate period the surface of the solid is wet with liquid and the rate of evaporation is not a function of the water content; the major factors affecting the rate of drying in this period are the air velocity past the surface, heat conduction from adjoining dry surfaces, and radiation from the surroundings. The rate of drying falls off during the falling-rate period either because the wetted surface decreases or because the rate of internal liquid diffusion becomes controlling. Either of these mechanisms of drying or each in turn may prevail during the falling-rate period. When internal liquid diffusion is controlling, there is a tendency for the evaporation to occur not at the surface, but at points within the solid structure. For Part II see *Ceram. Abs.*, **9** [5], 385 (1930). R.G.M.

Plasticity of ceramic pastes. ANON. *Feuerungstechnik*, **17** [11], 126–27 (1929).—Plasticity cannot be measured by any single test. A material in a plastic state can (1) be shaped and will keep this shape, (2) when dried it attains a certain solidity, and (3) while plastic absorbs a certain quantity of finely-ground solid substances. M.V.K.

Quick drying. ANON. *Brit. Clayworker*, **38** [455], 447–48 (1930).—Safe drying takes place at a maximum speed only when the proportion of moisture, volume, and temperature of the air are properly controlled. For each clay and kind of article there is a maximum air volume which can be applied in a given time. For quick drying of the fresh ware, air should be used which is almost saturated and the nearer the completion of the drying, the drier and hotter should be the air. These conditions are provided in the tunnel drier. In other driers the temperature and humidity is changed progressively. In a chamber or corridor drier any chamber can be "set" to deal with specially damp goods, the other chambers being arranged to deal with drier articles. For hot floors, do not have too high a roof as this involves much loss of heat. Many driers are much slower than they need be. R.A.H.

Heat management in ceramic drying plants. OTTO TH. KORITNIG. *Sprechsaal*, **63** [14], 245–47 (1930).—Economical drying with any system is only possible when the closely related factors, humidity and temperature, are carefully observed and regulated. The water content of the ware depends on the quantity and plasticity of the clay ingredients and the method of shaping; it varies from 6 to 30% and must be removed. The drying process can be divided into 4 parts: (1) partial shrinkage of the mass and reduction in volume, (2) drawing together of the clay constituents till they come in contact, (3) continuation of shrinkage and evaporation of the remaining water, (4) shrinkage is completed and the particles are in very close contact. M.V.K.

Consultants in heat technology. ANON. *Glashütte*, **60** [3], 39–40 (1930).—Program of activities of the Bureau of Consultants in Heat Technology of the German glass industry. L.T.B.

Methods of crushing, washing, and grinding barite in France. ROBERT D. LANCE. *Mines, Carrières, Grandes Enterprises*, pp. 97–107 (Sept., 1929); *Pit and Quarry*, **19** [4], 61–62 (1930).—Natural barium sulphate or barite, $BaSO_4$, known also as heavy spar, is found in liberal deposits in most of the southeastern quarter of France. Barite is found in agglomerated masses of crystalline elements of varying form. Grinding is done either by the wet or by the dry method. E.P.R.

Organized research for industries. EDITORIAL. *Mech. Eng.*, **52** [5], 570 (1930).—Commercial companies can undertake what might be called fundamental research only in exceptional cases, particularly as it is extremely difficult to keep the results confidential. Several attempts to carry on such research by some central organization for the benefit of the entire industry have been made. One of the best-organized attempts has been initiated by the Engineering Foundation. This undertaking is to critically review the literature dealing with iron and its alloys and to conduct research in the basic field of iron metallurgy. A similar movement has been made by the Ontario Metal Industries Research Assn. of Canada. H.W.A.

Basic economic structure of process industries. ANON. *Chem. Met. Eng.*, **37** [1], 2–3 (1930).—Tables, charts, and graphs showing essential production figures for the process industries. G.R.S.

Engineer as ruler. HUGH P. VOWLES. *Mech. Eng.*, **52** [2], 103–104 (1930).—A general discussion of the dependence of the modern community on the engineer is given. The historical account of the architectural and structural undertakings of Gudea, a Sumerian Engineer-Ruler of 2600 B.C. is quite interesting. H.W.A.

Value of charts in clayworking. ANON. *Brit. Clayworker*, **38** [455], 448–49 (1930).—Charts are valuable in showing the progress of a business financially; in recording the firing of kilns, the conditions in a continuous drier, or the sales and stocks of goods. Pyrometer-charts are being used for keeping a record of the firing of kilns; many continuous driers, also, are fitted with a recording hygrometer and thermometer, which show in graphic form the condition of the atmosphere inside the drier. The graphic recording of sales and stocks is unsurpassed as a means of showing at a glance whether any goods are moving slowly or are going well. The article further discusses in detail the use of the chart for showing the condition of a company in regard to its financial matters. R.A.H.

Problems of the consumer. E. ST. ELMO LEWIS. *Brick Clay Rec.*, **76** [8], 519–22 (1930).—This article is an excerpt of a talk given at the Common Brick Manufacturers Association's convention held in Memphis. It contains some very fundamental ideas about running a modern business. E.J.V.

Law of mechanic's lien involving clay products. LEO T. PARKER. *Brick Clay Rec.*, **76** [9], 590–94 (1930).—Cases involving various different circumstances in which clay products are involved in litigations are cited to illustrate the interpretation of the law. E.J.V.

Vitalizer of business. K. C. FARNSWORTH. *Ceram. Ind.*, **14** [5], 521–24 (1930).—The close connection in recent years between industrial progress and industrial research is significant. The large industrial enterprises have been developed as much through the organization of their scientific departments as through that of their operating departments. Over one thousand industrial research laboratories employing over ten thousand trained research workers are in existence in the U.S. F.P.H.

Developments in management. From a paper on "Scientific Industrial Management" by L. P. ALFORD. *Iron Age*, **125** [15], 1082 (1930).—Production control will be followed by simplified methods including codification and formulas. See also *Ceram. Abs.*, **9** [1], 71 (1930). E.C.C.

Heavy Clay Products Institute. ANON. *Clay-Worker*, **93** [5], 338–40 (1930).—A detailed report of the organization meeting held in Washington, D. C., April 2, 1930. Papers read are enumerated and one is briefly reprinted. E.J.V.

New trade association. ANON. *Clay-Worker*, **93** [4], 273 (1930).—The clay mining companies, including importers and jobbers, are about to organize a trade association in that industry. Several of the leading companies mining clays of different kinds for use in ceramics, paper, rubber, and many other products in which clays are used, are

discussing the many advantages that would accrue to both producer and consumer in this field. Clay mining is one of our largest industries, and is growing in importance every year as new uses for the many different types of clay are found. There are over 100 clay mining companies in this country. It is not generally known that there are over 100 different types of clays produced and used in as many different products, *e.g.*, fine china, porcelain, terra cotta, fireclay products, chemical retorts, bath tubs, etc. It is planned to give careful study to the standardization of different classes of clay, to carry on research in an effort to improve the quality and to find new markets for the clay, as well as for all products in which clay can be used. E.J.V.

Commercial structure of American chemical industry. ANON. *Chem. Met. Eng.*, **37** [1], 15–17 (1930).—A qualitative study of the products and markets of more than a hundred firms. G.R.S.

Financial structure of American chemical industry. T. M. SWITZ. *Chem. Met. Eng.*, **37** [1], 9–14 (1930).—A summary of the facts concerning the size of various sections of American chemical industry and of leading European cartels. G.R.S.

Long-time trends in chemical producing and consuming industries. T. M. SWITZ. *Chem. Met. Eng.*, **37** [1], 8 (1930).—Nine charts indicate the past and prospective rates of growth of chemical producing and consuming industries. G.R.S.

Where heavy chemicals are made and consumed. ANON. *Chem. Met. Eng.*, **37** [1], 4–5 (1930).—Maps and tables are shown. G.R.S.

Engineering education. A. A. POTTER. *Mech. Eng.*, **52** [4], 503–506 (1930).—Importance and value of a technical education are discussed. H.W.A.

Analysis of engineer registration laws of the U.S. AMER. ENGINEERING COUNCIL. *Mech. Eng.*, **52** [3], 215–18 (1930). H.W.A.

Economic status of engineers in the federal service. ANON. *Mech. Eng.*, **52** [2], 142–48 (1930).—The advantages and disadvantages which the federal service has for engineers are pointed out. The conditions which should be remedied in order to improve the efficiency of the service are given. H.W.A.

General advancement in clay and ceramic industries. ANON. *Chem. Met. Eng.*, **37** [1], 24 (1930).—The past year was regarded as good in ceramic industries, although pottery and common brick industries suffered from foreign competition, and the building materials manufacturers found their production exceeding consumption. There was a marked tendency toward installation of tunnel kilns. Kiln design has been improved resulting in greater fuel economy and better output. Machine-made terra cotta has been introduced. Mechanical formation, principally in hydraulic presses, is a definite trend in the refractories field. In the enameling industry, electric furnaces of the continuous tunnel type have spread widely. The most interesting development in the heavy clay products industry is the preliminary production of light weight structural units of fired clay. Face and enameled brick are enjoying a revival while superrefractories of silicon carbide, fused alumina, and zircon are on the increase. Insulating brick, refractory cement, and the so-called "monolithic" fire brick have found widely extended use. Highly aluminous brick, such as those made from artificial mullite and diaspore, have advanced decidedly both in production and application. Applied research has aided the ceramic industries. G.R.S.

Metallurgical research from a chemical point of view. H. W. GILLETTE. *Ind. Eng. Chem.*, **22** [3], 232–40 (1930).—G. discusses (1) importance of metallurgy, (2) relation of metallurgy to chemistry, (3) expensive equipment necessary, (4) trend toward centralization of research, (5) the training of research men, (6) institutions fostering research, (7) buildings and endowments, (8) coöperative research, (9) utilization of research facilities by industry, and (10) metallurgical research abroad. R.G.M.

Institute of Metals. ANON. *Engineering*, **129** [3350], 398(1930).—Some additional papers read at the annual meeting of Institute of Metals are described. *Ibid.*, **129** [3521], 383–85 (1930).—Proceedings of the 22nd annual general meeting of the Institute of Metals held on March 12 at the Institution of Mechanical Engineers. A résumé of the papers read is given. A.A.

French ceramists tour in America. ANON. *Bull. Amer. Ceram. Soc.*, **9** [5], 151–52 (1930); *Glass Ind.*, **11** [5], 120–21 (1930); see also *Ceram. Abs.*, **9** [6], 484 (1930). E.J.V.

Coöperation in the clay industries. ROSS C. PURDY. *Clay-Worker*, **93** [5], 352–53 (1930); *Bull. Amer. Ceram. Soc.*, **9** [5], 135–39 (1930).—A plea is made for coöperation in the clay industries pointing out how the various branches are connected and should support one another. E.J.V.

High-temperature insulation materials. ANON. *Commercial Stand. Monthly*, **6** [10], 297 (1930).—Tentative final drafts of standard specifications for molded insulation coverings for temperatures over 550°F; diatomaceous earth, granular, calcined; and insulating brick and mortar have been submitted to the membership and others concerned for comment and ballot vote. E.J.V.

Josiah Wedgwood Bicentenary. VI. ANON. *Pottery Gaz.*, **55** [635], 790–96 (1930).—A brief biographical sketch of Josiah Wedgwood and the history of the Wedgwood works are given. Various kinds of pottery produced are described. Illustrated. **VII.** *Ibid.*, pp. 806–808.—A detailed account of the program to be followed during the Bicentenary celebration is given. **VIII.** BERNARD RACKHAM. *Ibid.*, pp. 819–22.—The conditions in pre-Wedgwood days are reviewed briefly. Queen's ware and other ware are discussed. Wedgwood's organized methods, personal qualities, and capacity for organization are cited. **IX.** ANON. *Amer. Traveler's Gaz.*, **80** [2], 14–17 (1930); partially reprinted in *Bull. Amer. Ceram. Soc.*, **9** [4], 132–33; [5], 173–75 (1930). For Part V see *Ceram. Abs.*, **9** [6], 481 (1930). E.J.V.

Josiah Wedgwood. HERBERT READ. *Studio*, **96** [396], 31–34 (1930).—Some outstanding changes in pottery craftsmanship produced by Josiah Wedgwood were as follows: (1) improvement of buff earthenware known as cauliflower ware; (2) creation of cream earthenware (Queen's ware) which is noted for its practical fitness to function as spouts, lids, center of gravity, relative capacity of vessels, handles, etc.; (3) invention of basalt ware (Egyptian black); (4) a hard stoneware and jasper ware; (5) a semiporcelain stained throughout with oxides (blue, lilac, sage-green, etc.); (6) mottled ware imitating stones as agate and granite as well as the unglazed red stoneware rosso antico; and (7) buff terra cotta as bamboo and cane ware. The famous relief medallions carried out in series are a branch of the jasper ware, Flaxman being the chief artist and modeler. Illustrated. E.B.H.

Progress in glass technology at Sheffield during 1928-29, under the auspices of the Glass Research Delegacy. ANON. *Jour. Soc. Glass Tech.*, **13** [52], 262–69 (1929).—Changes in staff personnel and the difficulties encountered in filling the vacancies were emphasized. The creation of a scholarship to stimulate greater interest in the possibilities of glass technology as a vocation was announced. An outline was given of the educational work covered in the three courses of lectures in the Summer School in Glass Technology. A summary of the research work done in the past year was presented and a list of departmental publications was given. G.R.S.

Society of Glass Technology, December meeting. ANON. *Engineering*, **129** [3344], 195 (1930).—A summary of 3 papers read at the last meeting of the Society of Glass Technology for the year 1929 held in the Science Museum, London, on December 18, 1929. A.A.

Society of Glass Technology, January meeting. ANON. *Nat. Glass Budget*, **45** [42], 3 (1930); *Pottery Gaz.*, **55** [633], 447–48 (1930).—At a meeting of the Society

of Glass Technology held in Sheffield, England, on January 15, 1930, the following three papers were presented: "Influence of Manganese Oxide on Some Properties of Glass," by A. A. Childs and Violet Dimbleby; "Note on the Formation of Sodium Sulphate in Glass Tank Furnaces," by W. E. S. Turner; "Physical Properties of Soda-Silica Glasses. Part I. The Thermal Expansion," by W. E. S. Turner and F. Winks. E.P.R.

Society of Glass Technology, February meeting. ANON. *Glass Ind.*, **11** [4], 87 (1930); *Nat. Glass Budget*, **45** [47], 12 (1930); *Pottery Gaz.*, **55** [634], 650–53 (1930); for abstract see *Bull. Amer. Ceram. Soc.*, **9** [5], 172–73 (1930). E.J.V.

Italian glass and pottery market. ANON. *Pottery Gaz.*, **55** [635], 834–35 (1930); for abstract see *Ceram. Abs.*, **9** [6], 482 (1930). E.J.V.

German exports of porcelain tableware. A. DOUGLAS COOK. *Commerce Repts.*, **18**, 302 (1930).—Exports of porcelain tableware from Germany have shown a steady decrease since 1926 because of the protective-tariff policies of foreign countries and higher production costs. During the war other countries began the production of porcelain, and have maintained and strengthened their position with the assistance of high duties. Exports in 1929 declined 4% in weight, as compared with 1928. Increasing competition from other producing countries is one cause of the decline. In order to offset the decline in exports, repeated attempts have been made to increase domestic sales of porcelain tableware, but in 1929 they were estimated to have declined 10% in quantity, as compared with 1928. Also, sales of the porcelain fancy and ornamental ware industry decreased 20%. The Association of German Table Porcelain Manufacturers has established a special porcelain propaganda division which has started a publicity campaign all over Germany to increase domestic sales. E.J.V.

How Europe fosters its cement industries. FRANCIS MILTON. *Pit and Quarry*, **18** [12], 83–86 (1930).—The world output of cement has increased 78.5% since 1913. Divisionary production, based upon information compiled by the economic section of the League of Nations (July, 1929), shows the changes in the relative volume of output of the various producing regions. E.P.R.

Diathermic capacity of chimneys of reënforced concrete. OTTO GRAF. *Arch. Wärmewirt*, **1**, 23 (1930); *Tonind-Ztg.*, **54** [28], 487 (1930). M.V.K.

General trend of developments in feedwater treatment. SHEPPARD T. POWELL. *Mech. Eng.*, **52** [2], 106 (1930).—The combination of chemical and zeolite softening, additions of coagulants with softening agents, the continuous blowdown system, and steam purifiers have revolutionized feedwater treatment. H.W.A.

Pulverized fuel installation on the S. S. Hororata. ANON. *Engineering*, **129** [3348], 346–48 (1930).—The earlier installation is reviewed and the recent modifications and additions are described and illustrated. A.A.

Avoiding smoke from boilers. ANON. *Brit. Clayworker*, **39** [456], 16 (1930).—A great improvement can be effected if stokers keep in mind the following points: (1) keep fires bright, (2) fire lightly and often, (3) fire alternate sides, (4) keep the water at normal working level, (5) use the side dampers, (6) clean out alternate sides, (7) clean out quickly and thoroughly, (8) keep down scale and soot, (9) keep an eye on the brick work, (10) use the grids in the fire door intelligently. R.A.H.

Some problem of dust collection. J. W. GIBSON. *Colliery Guardian*, **140** [3603], 234; [3604], 324–25 (1930).—With pulverized fuel firing there has been a great increase in the amount of dust in the flue gases, which is objectionable. The problem of cleansing the flue gases of the entrained dust is usually tackled along one of four lines, *i.e.*, (1) by reducing the velocity of the flue gases to such a figure that the dust will fall out of the suspension by gravity: (2) use of an electrical precipitator; (3) washing; (4) centrifugal means; and (5) by means of a fabric filter. Considerations of space rule

the first method out generally. The particular advantages and disadvantages of each of the other four methods are discussed at length. E.J.V.

Automatic electrical control of boilers. SIEMENS AND HALSKE. *Colliery Guardian*, **140** [3603], 229–30 (1930); abstracted from *Tech. Blätter, Wochenschrift deut. Bergwerks-Ztg.*—A system of all-electrical control which is said to be adaptable to any type of boiler or system of firing, and enables a batch of boilers to be remotely-controlled is described in considerable detail. It is based on the principle of the Wheatstone bridge. E.J.V.

BOOKS AND BULLETINS

Work of the U. S. Bureau of Mines. SCOTT TURNER. Bur. Mines, *Information Circ.*, No. 6257, 55 pp. (1930).—The Bureau of Mines frequently receives requests for information regarding the details of its organization and nature of its activities. In response to such an inquiry a series of articles outlining the work of the Bureau as a whole and of its different divisions was prepared and published in the United States Daily, Washington, D. C., during Nov., 1929. These articles are reprinted in this report in the hope that they may assist in giving the public a more complete understanding of the aims and purposes of the Bureau and the methods by which it is laboring for the attainment of safer conditions and more efficient methods in American mineral industries. R.A.H.

Is smoke responsible for property damage? ANON. *Pit and Quarry*, **20** [1], 79 (1930).—The Dust Recovery and Conveying Co.'s Bulletin 1-B is an article by the commissioner of trade waste of Cleveland, O., pointing out the desirability of recovering carbon from industrial smoke and gases. E.P.R.

Industrial Ceramics. (La Céramique Industrielle.) ALBERT GRANGER. *Z. Ver. deut. Ing.*, **74** [12], 384 (1930); for abstract see *Ceram. Abs.*, **9** [1], 68 (1930). L.T.B.

Economies of Combustion in Boiler Furnaces. (Wärmewirtschaft im Kesselhaus.) ERNST PRAETORIUS. Published by Theodore Steinkopff, Germany. 430 pp. 151 figures. Reviewed in *Chaleur ind.*, **11**, 212 (1930). A.J.M.

Making and Firing of Glazed Ware. H. ANSELL AND A. B. SEARLE. H. Greville Montgomery, London, 1929. 264 pp. Reviewed in *Tonind.-Ztg.*, **54** [28], 485 (1930).—This work was begun by A. as a series of articles in the *British Clayworker* and with the coöperation of S. enlarged and completed and now published as a book. The appearance of this work fills a great need for coherent information on the subject of the technique of enamel glazes. Although the book treats only English raw materials, its appearance is of great interest while the many recipes and counsels will be of great service. The different English refractory clays are discussed in regard to their occurrence and behavior. Subsequent chapters are devoted to instructions for the preparation of white and colored glazes, engobes, and enamels, with a great number of recipes, most of which were thoroughly tested by the authors. The chapters following discuss the coating and firing of enamels on refractory brick, pipes, terra cotta, sanitary ware, and salt-glazed products. The preparation of porcelain and ware for general use is briefly outlined as it rests on entirely different bases. This book will be of great practical use. M.V.K.

Determination of porosity by absorption of water. E. KÖHLER. *Trans. Ceram. Research Inst.* [Moscow], **18**, 14 pp. (1929).—K. worked out a method for testing the absorption of ceramic bodies of different structures. The action of cold and boiling water on the durability of saturation of bodies was also tested. Porous, especially coarse-grained, bodies underwent a complete saturation after 4 hrs. of boiling in water; the fine grained and the partially vitrified bodies with a small porosity were not completely saturated even after boiling 8 hrs. Bodies soaked in cold water for several days showed an increase in weight. K. concludes that a boiling of 4 hrs. and an additional

soaking in cold water for 2 days is a suitable method for the comparative absorption tests for bodies of different structure. M.V.K.

Achema Year-book, 1928 to 1930. Report on the position and development of chemical apparatus. Edited in association with scientific and technical experts, by Dr. Max Buchner, Hannover. Seelzs b. Hannover u. Berlin, 1930. Price 10 Rm. Those interested in chemical apparatus and those who expect to pay a visit to the Achema VI, will get free of charge and as long as available the Achema Year-book, on sending Rm. 0.40 as postage (abroad: 2 international postage coupons).

The 1928 to 30 Achema Year-book, as precursor and instructor, is designed to prepare the visitor for the Jubilee Achema VI, which took place from the 10th to the 22nd of June, 1930, at Frankfurt a.M., with a floor space of 20,000 sq. m., the greatest show of chemical apparatus in the world as yet. The preparation is fundamental, and, at the same time, inspiring and attractive. Not less than 52 important leaders in science, industry, technical affairs, and administration have dedicated to the Achema appropriate articles for the visitor's guidance, to which a personal note is lent by the inclusion of photographs and autographs. Thus the multiplicity of and relation between the interests combined in the Achema are effectually demonstrated.

The creator of the Achema and editor of the Year-book, Max Buchner, sketches, in the review, "Ten Years of the Achema," the holding of the first (1920) Achema in Hannover, and the upward movement to Stuttgart (1921), Hamburg (1922), Nurnberg (1925), Essen (1927). The growing success has justified the introduction in 1930 of an exhibition of apparatus to strengthen the connection between engineer and chemist, producer and user, of chemical apparatus.

In the scientific section, Kirschbaum, of Karlsruhe, tells how now in Germany the chemical engineering field is introduced, with an organized plan of study, into the curriculum of the technical schools, so that the German "engineer-chemist" will soon represent an important calling. In regard to the proposed special exhibition within the Achema VI itself, H. Jentgen of Berlin deals with mechanical problems of the rayon industry. A. Traub of Berlin reviews the advantages, possibilities, and limits of the standardization of large chemical plants, and the standardization of laboratory apparatus is systematically dealt with by U. Ehrhardt of Bitterfeld.

In the technical-industrial part a great number of exhibiting firms offer comprehensive, informative previews of important exhibits. In circles of technical manufacturers, an actual scientific and technical presentation in work and picture is being prized as an essential to business. The collection contains much valuable information and advice for plant and laboratory.

The register of sources of supply is, according to the system informer Achema Year-books, still more complete and exhaustive and is composed of some 1200 key-words. An innovation is the illustrated index at the end, in which in the future a greater number of firms will be represented.

The Achema Year-book has lasting value as a means of education and information in the field of chemical apparatus, and is assured of an honorable place in the literature of chemical technology.

Industrial Dust and Lung Tuberculosis. II. Cement, Tobacco, and Argillite Dust. (Gewerbestaub und Lungentuberkulose. II. Zement, Tabak, und Tonschieferstaub.) R. W. JÖTTER, THEA KORTMANN, AND G. SCHULTE. Julius Springer, 1930. 125 pp. 56 illustrations. Reviewed in *Tonind.-Ztg.*, **54** [28], 485 (1930). M.V.K.

Permanency of Building Materials and of the Elements of Construction. (Die Dauerfestigkeit der Werkstoffe und der Konstruktionselemente.) OTTO GRAF. Julius Springer, Berlin. 131 pp. Rm. 14. Reviewed in *Tonind.-Ztg.*, **54** [28], 485 (1930).—The knowledge of the properties of building materials in use, especially their dura-

bility, is important. Important building materials are discussed, *i.e.*, rocks, concrete, reënforced concrete, wood, and glass. This book can be recommended to engineers and to professional men. M.V.K.

Encyclopedia of Technical Chemistry. Vol. IV. Edited by F. ULLMANN. 838 pp. 402 illustrations. Reviewed in *Tonind.-Ztg.*, **54** [31], 536 (1930); for abstract see *Ceram. Abs.*, **9** [6], 408 (1930). M.V.K.

Yearbook of the Ceramists and Glassmakers of France. (Annuaire des céramistes et verrières de France.) ANON. 1930 ed. 538 pp. Published by J. Hogrel, Paris. Price 40F. Reviewed in *Rev. belge ind. verrières*, **1**, 44 (1930). A.J.M.

Strength of Materials. J. O. DRAFFIN. John Wiley & Sons, Inc., New York. Reviewed in *Engineering*, **129** [3343], 163 (1930).—A text book on the strength of materials suitable for architects and others not having an extended knowledge of mathematics. See also *Ceram. Abs.*, **8** [8], 614 (1929). A.A.

Principles and Practices of Lubrication. ALFRED W. NASH AND A. R. BOWEN. Chapman and Hall, Ltd., London. 15s. Reviewed in *Colliery Guardian*, **140** [3611], 1014 (1930).—After a brief introduction to the subject of lubrication, friction is discussed in a clear nontechnical way. The determination of specific gravity and viscosity is described and the value of these tests is explained. The design and lubrication of bearings is handled well. A description is included of the nature of surfaces working in contact with one another and details are given of the composition of bearing alloys suitable for various loads and speeds. This is followed by a consideration of the principles of lubrication and a brief description of various systems of lubrication. After an interesting account of the sources of lubricants and a tabulation of the various purposes for which the different lubricants are used, a brief description of the chemical constitution of petroleum products and of the fatty oils used as lubricants is given. Chapters are devoted to industrial lubrication, mechanical friction testing machines, and care of lubricants. An appendix, containing some useful data, completes the book. E.J.V.

New system of quarrying at Monolith California plant. ANON. *Monolith Mixer*, Nov., 1929; reviewed in *Pit and Quarry*, **19** [5], 100 (1930).—The Monolith Portland Cement Co. has issued a pamphlet describing the new tunnel-quarrying methods in use at Monolith. E.P.R.

Standard Costs: Installation, Operation, and Use. G. CHARTER HARRISON. The Ronald Press Co., New York City. 304 pp. Price $5.00. Reviewed in *Brick Clay Rec.*, **76** [9], 600 (1930).—In this book H. has made available for the first time the exact details of the methods he has worked out. He gives practical procedure for setting standard costs in factory, shop, and sales office; designing, installing, and operating standard cost systems; checking actual against standard costs, getting at causes of cost and profit variations; reporting results of the application of standard costs. His methods cover the entire problem, from oompiling the original data through determining budgets and measuring the results of operations. H.'s methods give a practical basis for estimating the cost of any item of product in advance, and controlling such costs during the operations involved. E.J.V.

Labor Problems. GEORGE S. WATKINS. Cloth, 726 pp., $5^1/_4$ x 8 in. Published by Thomas Y. Crowell Co. Reviewed in *Abrasive Ind.*, **11** [5], 38 (1930).—This book, originally written in 1922 in its new and revised form, gives an up-to-date and comprehensive summary of labor problems in modern industry. Its main purpose is to acquaint the readers with the actual facts and conditions that enter into industrial life. E.P.R.

Industrial and General Administration. HENRI FAYOL. Translated from the French by J. A. Coubrough. 84 pp. Sir Isaac Pitman and Sons, Ltd., London. Price

3s 6d. Reviewed in *Colliery Guardian*, **140** [3613], 1201 (1930).—F.'s method of administration may be defined as an orientation of management based upon the close examination of facts. The principles which he has enunciated have been applied in numerous directions. The book is divided into four parts: (1) need for and possibility of teaching administration; (2) principles and elements of administration; (3) personal observations and experiences; and (4) lessons of the war. The first two parts form the subject of this volume. The third and fourth parts, hitherto unpublished, will be included in a second volume. E.J.V.

Work Routing in Production. JOHN YOUNGER. 115 pp., $5^1/_2$ x $8^1/_2$ in. Published by The Ronald Press Co. Reviewed in *Abrasive Ind.*, **11** [5], 38 (1930).—The data are taken from the current practice of various leading manufacturers in the U.S., and emphasis is laid on the ways in which the methods under discussion can be applied to bring about lower production costs and how they can be fitted to varying conditions. E.P.R.

Depth attainable by electrical methods in applied geophysics. A. S. EVE, D. A. KEYS, AND F. W. LEE. Bur. Mines, *Tech. Paper*, No. 463, 58 pp. (1929).—The primary objects of geophysical prospecting are to guide the mining engineer in such a manner as to avoid useless expenditure of time and money in drilling for ore or for oil at random and to select for him those definite points or localities when the indications point to the presence of minerals in such quantities as to promise profitable return. The question of depth from which indications can be obtained is so fundamental that the Bur. of Mines decided to devote the summer months of 1928 to its investigation. The report describes the results obtained. Price 15¢. R.A.H.

PATENT

Coloring clay. ROBERT T. VANDERBILT. U. S. 1,755,616, April 22, 1930. Method of coloring clay, which comprises breaking up the clay into lumps, spraying the clay in lump form with a solution of a dye to color part of the clay particles of the clay lumps, and thereafter pulverizing the clay lumps and thoroughly mixing the dyed clay particles with the undyed particles to effect substantially uniform distribution of the dyed particles throughout the clay and to give a final pulverized clay product of substantially uniform appearance.

Book Reviews

Pattern Designing. ARCHIBALD H. CHRISTIE. Clarendon Press, Oxford, 1929. 2nd ed. Price $3.50. 60 plates, 360 drawings. A clear and detailed analysis is given of the structural mechanism of formal ornament. The traditional methods which have been used in building elemental design material into different pattern forms are studied from numerous well chosen examples grouped on the basis of common structural features rather than with regard to historical periods. C.'s thesis is this: "The beauty of a pattern is not due so much to the nature of its elements as to the right use of them as units in a rhythmic scheme. Their posturings, runs, staccato punctuations, strong and weak alternations, etc., so far from being more or less accidental are in reality calculated effects designed to appeal directly to a rhythmic sense. Rhythmic effect is the primary aim of all formal ornament. It is the varied rhythmic powers vested in different structural methods that make them the most important consideration in pattern composition." Careful study of this book cannot fail to give helpful inspiration to every designer, whether his interest may lie in the traditional field from which most of the examples are taken or in contemporary design, which after all cannot escape the old fundamental structural frame on which to hang its experiments in the direction of fresh ideas and treatment. A.E.B.

Handbook of Chemistry and Physics. CHARLES D. HODGMAN AND NORBERT A. LANGE. Published by Chemical Rubber Publishing Co., Cleveland, Ohio, 1929. 14th ed. 1386 pp. Price $5.00. With the increased demand for the Handbook in this country and abroad, have come many requests for scientific data not found in previous editions. As a result a very large variety of new material appears for the first time in this edition. Chief among these additions is an entirely new table of the wave-lengths of the principal lines in the emission spectra of the elements produced by the arc, spark, or Geissler tube. The intensities of lines are indicated by the numbers one to ten, the latter, the higher intensity. Other characteristics of the lines are indicated by symbols. The section on ceramics has been enlarged by the addition of shrinkage conversion tables; tables giving the properties of dry and saturated air; weights of saturated and partly saturated air for various barometric conditions; altitude and temperature density tables and corresponding pressures and velocities of dry air. Among other additions of special interest are the tables of transmission of ultra-violet and infrared radiation by various neutral and colored glasses.

Tables have been added on the heat of formation and the heat of combustion of organic compounds and the combustion constants for gases and the heat of combination and combustion of representative coals. For the lacquer and varnish manufacturers, a table has been introduced giving the physical and chemical constants of resins, oleo resins, and gum resins. In addition, tables of coefficients of thermal expansion of metals and other substances, new and revised tables on the density of the elements, a much enlarged table on the physical constants of common minerals, percentage composition of anti-freeze solutions, a table of constant humidity of many compounds, special tables on the conversion of thermometer scales, and a much enlarged table of indicators have been added. Mention should also be made of several pages of equations of representative qualitative volumetric reactions with gravimetric equivalents. The Mathematical section has been enlarged by the addition of a table of anti-logarithms and complete, simple, and compound interest tables. The following have acted as collaborators in the revision of the Handbook and in suggesting and compiling the new data in this edition: A. I. Andrews, Ph.D., Associate Professor of Ceramic Engineering, University of Illinois; Robert A. Baxter, Ph.D., Professor of Chemistry, Colorado School of Mines; W. A. Koehler, Ph.D., Assistant Professor of Chemical Engineering, West Virginia University; Howard B. Lewis, Ph.D., Professor of Physiological Chemistry, University of Michigan; Thomas W. Mason, M.S., Associate Professor of Analytical Chemistry, Pennsylvania State College; Merle Randall, Ph.D., Professor of Chemistry, University of California; O. R. Sweeney, Dean of Chemical Engineering, Iowa State College; A. E. R. Westman, Ph.D., Associate Professor of Ceramics, Rutgers University; Ivan Rennerfelt, Electro-Metallurgist, Stockholm, Sweden; Nils Wigren, Instructor of Analytical Chemistry, University of Upsala, Upsala, Sweden.

The Scientific Fundamentals of Gravity Concentration. JOSEF FINKEY, School of Mines, Sopron, Hungary. Translated into English by C. O. Anderson and M. H. Griffitts. Bulletin, School of Mines and Metallurgy, University of Missouri, Rolla, Mo. Price $1.00. This treatise is largely confined to a mathematical exposition of gravity concentration processes and the previous experimental works of Richards, Stokes, Wagoner, Rittenger, and others are utilized to interpret the deductions. Of necessity, F. employs higher mathematics throughout his work, and uses hyperbolic functions to express his various conclusions. Equations are derived for the mechanics of gravity concentration including the dynamic action of a stream of water against solids of various shapes and conditions, the free fall of spherical solid bodies in still water, the motion of a spherical body in a vertical stream of water, and the movement of a spherical body in a stream of water flowing over an inclined plane. These basic

equations are used for deducting the principles of screening and classifying according to settling rates and for the more complex processes of jigging and tabling. Due to the complexity of some of the equations, F. has derived some simplified forms which hold for practical operation. In addition to the derivation of fundamental equations, the treatise contains many observations and conclusions regarding gravity concentration practice, particularly European practice. This should be of value to the operator who is attempting to better his present results. It is believed that this translation of Josef Finkey's treatise will find favor both in the operation and teaching field of ore dressing. The authors are to be praised for their efforts in translating this work of fundamental principles and the U. S. Bureau of Mines in coöperation with the Missouri School of Mines for sponsoring it. It will take its place among the "classics" of ore dressing along with the works of Rittenger and Richards. There is room for further research in this branch of ore dressing which has recently been eclipsed by the tremendous amount of work done in flotation.

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the "bottle neck" of the Ceramic Industry

Here is a typical example of *controlled limit drying* made possible in a Carrier Dryer through automatic and accurate humidity control. This is of particular importance where it is necessary to bring the product to a definite and limited moisture content, preliminary to a process operation which precedes final drying.

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Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering, COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in co-operation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS
Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

NINE INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and ornamental ceramics

FOUR INSTRUCTORS, TWO COURSES *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT *Curriculum*—Ceramic Technology and Engineering

TWO INSTRUCTORS *Founded 1923* *Director:* A. V. HENRY

VIRGINIA POLYTECHNIC INSTITUTE

BLACKSBURG, VIRGINIA

Curriculum—Ceramic Engineering

Founded 1929 *Head of Department:* J. W. WHITTEMORE

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering
THREE INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applied to ceramic manufacture
TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology
TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES AND METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Founded 1926* — *Head of Department:* M. E. HOLMES

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries

Founded 1926 — *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY

Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries
THIRTEEN INSTRUCTORS — *Head of Department:* JAMES R. HOPKINS
Founded 1927 — *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA

NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts — *Curriculum—Ceramic Art*
Founded 1927 — *Head of Department:* JOHN N. FRANK

UNIVERSITY OF ALABAMA

UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

Curriculum—Technical ceramic courses given by Dept. of Chemistry and Metallurgy
TWO INSTRUCTORS — *Director:* STEWART J. LLOYD *Ceramics:* T. N. MCVAY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASS.

Curriculum—Graduate Study and Research in Ceramics
FIVE INSTRUCTORS — *Founded 1929* — *Head of Course:* F. H. NORTON

LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE

BATON ROUGE, LA.

Curriculum—Optional Courses now given by the Department of Geology
THREE INSTRUCTORS — *Ceramics Dept. founded 1925* — *Head of Dept.:* H. V. HOWE

STANFORD UNIVERSITY

Department of Mining Engineering, STANFORD UNIVERSITY, CALIFORNIA

Curriculum: Two-year graduate course in ceramic engineering, offering various combinations with mining and metallurgical engineering. Research in ceramics and non-metallics.
Director: THEODORE J. HOOVER — *Founded 1925* — *Professor in charge:* W. F. DIETRICH

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

E. DEF. CURTIS, MYRTLE M. FRENCH, ERWIN SOHN, W. N. HARRISON	Art, Enamel	J. T. LITTLETON, F. C. FLINT, C. F. GEIGER, DOROTHY A. TEXTER, R. F. SHERWOOD, E. H. FRITZ	Glass, Refractories, White Wares	H. D. CALLAHAN, L. A. DOUGHERTY, HOWELLS FRÉCHETTE, W. H. VAUGHAN	Terra Cotta, Heavy Clay Products

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Vol. 9 **July, 1930** **No. 7**

EDITORIAL

WILL CERAMIC ART EDUCATION PAY?

Yes, if it trains artists to develop products for specific purposes and to create products for the ever-changing needs. A ceramic art education that is concerned only with form and decoration will not pay.

For several years the manager of one of our largest potteries was a "buddy" with the buyer of a large chain store. They "knew what the trade wanted." They had the "expert judgment" of what would sell. But alas, the buyer was retired. The new buyer is not of the old school. He is a modern "stylist." The result is that because American general ware was so out of vogue he made his purchases abroad. The pottery manager wisely retired.

The interesting fact is that the ceramic artist at this pottery had developed new bodies, glazes, colors, shapes, and decorations, all of which the pottery manager and his buddy, the buyer, in their expert wisdom pronounced unsalable. When the modern buyer finally saw these developments he was enthusiastic for them and had he not placed orders elsewhere he would have taken some of these new lines which the old but now retired "buddies" rejected.

Another interesting fact is that under the new régime the ceramic artist contacts with the buyers, goes to the large markets to study the trends in architecture and nonceramic merchandise, and has advisory control over factory materials and processing; in fact, he is given parental directing influence in the creation, the upbringing, and in the final placement of his brain children. He does not presume the prerogatives of the managers of sales or production. He is merely their creating team mate.

No person trained only in design could thus serve this pottery. The potteries that will hold their own in competition today must have an artist who is enough of a ceramist to have advisory judgment of materials, mixtures, and processes. He must know these if he is to create new things and to see that they are produced under proper control.

Another large ceramic plant lost its ceramic artist. After he left, this plant had to discontinue many of its new and profitable lines because no one left after the disintegration of this ceramic artistic organization was allowed to control production of these special lines. This was a case where the new general manager did not have the same vision as his predecessor of the usefulness of a ceramic artist. The new manager did not want a ceramic artist in an advisory capacity to the production and sales managers. The business which this firm lost shows that an artist for designing alone is not sufficient.

The technical men and the artists of a third large ceramic plant were agreed that they had no use for a ceramic artist. Their idea was that he would upset their present smug organization. A cursory survey of the market solicited by this firm gives evidence that their purely technical and strictly artist designers will soon learn that they are not qualified to keep their product in demand; their product is losing favor.

The secret of ceramic ware success and the reason for distinctive ware reputation can be traced always to a most intimate team work in the factory, the studio, and among the trade. It is just as true that in each progressively developing and business getting manufacturer of industrial ceramic ware, the ceramic technologists and engineers have advisory process supervision and process control charge in the factory, and promotional and development responsibilities in the sales department. Analogous team mate responsibilities are had by the factory and sales managers in the department which is distinctively under the charge of the ceramic technologist or engineer.

The day never was when a ceramic artist, technologist, or engineer was serving himself or his employers most fully without team mate responsibilities in every department from production to sales.

Ceramic art education will pay if the training develops creative and process control judgment.

ACTIVITIES OF THE SOCIETY

AMERICAN CERAMIC CONGRESS

Cleveland Auditorium

Week of February 22, 1931

Plans and programs are developing rapidly for this Ceramic Congress. They already indicate that this Congress will be the most helpful educational event ever put on by the ceramic industries of America. It will be educational alike to the public and to the ceramic ware producers.

Already, in response to one letter to those who exhibited in Chicago and one letter to all ceramic ware producers generally, thirty firms have taken forty of the one hundred and sixty Exposition booths. The Exposition is one-fourth sold.

There remains one hundred and twenty booths to be sold. This is at once a task and an opportunity. No one believes that these one hundred and twenty booths will be sold without expenditure of a great deal of personal sales effort. Each member of the AMERICAN CERAMIC SOCIETY should understand that he is responsible for obtaining a "sell out" of the entire Exposition space.

Why these Meetings and this Exposition? Why live? Why strive for industrial success?

The ultimate answer to these and similar questions relates to personal profit and happiness. The American Ceramic Congress is an organized promotion of the ways and means with which each of us is striving to obtain personal profit and happiness.

Your interest in the success of these meetings and of this Exposition should rightfully be a very selfish one. It is a selfish personal enterprise that can be successful only by the coöperation of all persons having like selfish interests. The "selling out" of this Exposition is your personal problem and responsibility. It affects your personal profit and happiness.

NEW MEMBERS RECEIVED FROM MAY 1 TO JUNE 1

PERSONAL

Wm. D. Bozman, The Stark Brick Co., Massillon, Ohio.
Alberto Cheyre, Sociedad Fabrica Nacional de Envases y Enlozados, Casilla 232, Valparaiso, Chile.
Raymond Copin, Fonderies & Emailleries de Noyon, Noyon (Oise), France.
Delbert Alonzo Cronwer, 16 E. Broad St., Columbus, Ohio; Manager, The Colzon Lime Stone Products Co.
Murray C. Gautsch, 641 Magie Ave., Elizabeth, N. J.; Research Asst., Metal & Thermit Corp., Carteret, N. J.
Alfred Herman Johns, 1306 44th Ave. S. W., Seattle, Wash.; President, Pioneer Enameled Steel Prod. Corp.
Herbert V. Kaeppel, Managing Editor, *Brick and Clay Record* and *Ceramic Industry,* 407 S. Dearborn St., Chicago, Ill.
Hans Kohl, Klemens-Auguststrasse 16, Bonn, Germany; Direktor der Ludwig Wessel A.-G.
George Merz, Ceramic Engineer, Schamotte Fabrik, Skawina, Poland.
C. Thomas Miller, 122 Whitfield St., Pittsburgh, Pa.; Technical Asst., Harbison-Walker Refractories Co.
Thomas Edmund Ormiston, 1359 Belle Ave., Lakewood, Ohio; Industrial Engineer, General Electric Co., 925 Euclid Ave., Cleveland, Ohio.
Bertram C. Ruprecht, Chemist, Harbison-Walker Refractories Co., 122 Whitfield St., Pittsburgh, Pa.
Henry Schantz, 137 Wallace Ave., New Castle, Pa.; Shenango Pottery.

STUDENT

Edward E. Callinan, Ohio State University, Columbus, Ohio.
Elmer Francis Cirkal, Missouri School of Mines, Rolla, Mo.
William R. Powell, Missouri School of Mines, Rolla, Mo.

Membership Workers' Record

PERSONAL		PERSONAL (*continued*)	
R. R. Danielson	1	J. H. Stewart	1
Louis Douin	1	Hewitt Wilson	1
K. H. Endell	1	Office	1
R. L. Frink	1		
George Guthrie	1	Total	13
Fred A. Harvey	2	STUDENT	
M. R. Hornung	1	W. F. Copp	1
J. L. McFarland	1	C. M. Dodd	2
F. L. Steinhoff	1		
		Total	3
		Grand Total	16

ROSTER CHANGES IN MAY

PERSONAL*

Birch, Raymond E., 416 Oakland Ave., Pittsburgh, Pa. (O. S. U. Engineering Experiment Station, Roseville, Ohio).
Boudreau, James C., 303 Manor Road, Douglas Manor, Long Island, N. Y. (Kew Hall, Kew Gardens, N. Y.)
Callinan, J. Gavin, 1984 N. 4th St., Columbus, Ohio. (P. O. Box 878, Clarksburg, W. Va.)
Cooper, George W., *The Glass Industry,* 24 West 40th St., New York, N. Y. (50 Church St.)
Copp, Warren F., Frigidaire Corp., Dayton, Ohio. (Columbus, Ohio.)
Donnenwirth, A. L., Hanley Company, Summerville, Pa. (A C Spark Plug Co., Flint, Mich.)
French, Gordon E., Box 381, Woodbridge, N. J. (Perth Amboy, N. J.)
Goodrich, Hobart R., P. O. Box 94, Lincoln, Calif. (410 Riverdale Drive, Glendale, Calif.)
Goodson, Clifford C., 69 N. Berkeley Ave., Pasadena, Calif. (8676 Elizabeth, Huntington Park, Calif.)
Gosser, George W., Sistersville, W. Va. (550 Cambridge St., Coshocton, Ohio.)
Hagar, Donald, Cambridge Tile Mfg. Co., Box 836, Cincinnati, Ohio. (Covington, Ky.)
Hutt, Glenn A., Frigidaire Corp., Dayton, Ohio. (Columbus, Ohio.)
Kerr, W. B., W. B. Kerr Corp., 269 Erie Blvd., West, Syracuse, N. Y. (Iroquois China Co., Syracuse, N. Y.)
King, Melvin M., 8 Maple St., Maynard, Mass. (25 E. 4th St., Corning, N. Y.)
Oravec, Joseph A., 237 N. Dithridge St., Pittsburgh, Pa.; Vitro Mfg. Co. (4726 N. Kenton Ave., Chicago, Ill.)
Schoeninger, Irvin W., 6800 Normal Blvd., Chicago, Ill. (525 Marshall St., Milwaukee, Wis.)
Schultz, Frank C., 398 Vista Ave., Pasadena, Calif. (New Mexico Clay Products Co., Albuquerque, N. Mexico.)
Skinner, Sherrod E., 899 Longfellow Ave., Detroit, Mich. (343 Hart St., New Britain, Conn.)
Smith, Charles A., Box 271, Mexico, Mo.; Mexico Refractories Co. (Bigelow-Liptak Corp., Detroit, Mich.)

* Addresses within the parentheses ( ) represent the old address.

These roster changes which are published each month may be checked against the complete Membership Roster which was published in the July, 1929, issue of the *Bulletin.* Copies of this issue may be obtained from the Secretary's office, price $2.00.

Spencer, Charles D., Glass Technology Laboratory, General Electric Co., 1133 East 152nd St., Cleveland, Ohio. (Nela Park, Cleveland, Ohio.)
Stevens, Frank J., 414 Prospect St., Nutley, N. J. (343 Cortlandt St., Belleville, N. J.)
Uhrmann, Carl J., Jr., 4212 Gilbert Ave., Western Springs, Ill. (6252 S. Central Ave., Chicago, Ill.)
Wood, Wallace B., 5600 Miles Ave., Huntington Park, Calif. (Los Angeles, Calif.)

APPRECIATION FROM FRENCH CERAMISTS

Lunéville, May 12, 1930

Monsieur le Secrétaire Général:

We received on our boat the very kind letter of the AMERICAN CERAMIC SOCIETY wishing us a pleasant journey home.

Upon my return to Lunéville, still in vivid memory of it all, it is my pleasure again to express to you, as the representative of your SOCIETY, our deepest gratitude for the charming welcome which was ours during our journey through the United States, and for all your attentions however unpretentious they may have been, with which you did not spare to surround us, and above all for the very sincere cordiality of your reception.

My colleagues and myself still maintain unforgetfully in our memories the journey through your land. We have seen and admired wonderful factories, perfectly equipped, and working under that typical American management and organization which explains the success of most of your industries.

We wish to thank you especially for the reception tendered us at the office of the AMERICAN CERAMIC SOCIETY and at the University in Columbus and we beg you to express our deeply felt thanks to those who expended so much of their time for our entertainment.

Finally, please convey our gratitude to all the members of the AMERICAN CERAMIC SOCIETY and tell them that we shall be happy to receive them in turn on a trip through France. Accept, dear Sir, the expression of my special devotion.

EDOUARD FENAL
Gérant de la Faiencerie de Badonviller
Administrateur Délégué des Faienceries de Lunéville & de Saint-Clément

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THE JOSIAH WEDGWOOD BICENTENARY

28th May 1930

The AMERICAN CERAMIC SOCIETY,
2525 North High Street,
Columbus, Ohio, U. S. A.

Dear Sirs,

I am desired by the Council to thank you for so kindly sending delegates to help us to celebrate the Bicentenary of Josiah Wedgwood. Thanks largely to your assistance, I believe everything was a great success. I hope that they had a good time. These meetings must help to bind more closely the feelings of good fellowship which I trust will always prevail between our respective Societies.

Yours faithfully,

J. W. MELLOR

SILVER ANNIVERSARY HONORING DR. ALEXANDER SILVERMAN

Twenty-five years—a long while in prospect—a brief while in retrospect.

Service for twenty-five years of the sort that causes a great university to afford a large number of friends and professional associates an opportunity to give testimony to his contributions is indeed a remarkable service.

Alexander Silverman has rendered such service for twenty-five years and has so influenced and inspired his pupils and associates that on June 6 he was tendered a banquet and was presented with testimonials. As a chemist, a teacher, a ceramist, a citizen, and as a friend, our own Alex merits all the recognition which was given him on that occasion.

A life size oil painting of Professor Silverman was presented to the University of Pittsburgh by his former pupils. A print of this painting is shown here.

Dr. W. J. Holland, Chancellor Emeritus, and Dr. J. Steele Gow, the acting Chancellor, spoke in high praise from intimate personal knowledge of Dr. Silverman's work as a teacher and investigator. Ross C. Purdy, General Secretary, spoke on Dr. Silverman, a ceramist. Dr. H. E. Howe, editor of *Industrial and Engineering Chemistry*, related what Dr. Silverman and the University of Pittsburgh has contributed to science during the past twenty-five years.

The following is a biographical sketch and a partial record of Dr. Silverman's contributions to science, including ceramics:

Born, Pittsburgh, Pa., May 2, 1881, son of Phillip and Hannah (Schamberg) Silverman.
Educated in Pittsburgh public schools and Central High School.
Received Ph.B. degree in 1902 and M.S. degree in 1907 from the University of Pittsburgh, and A.B. degree in 1905 from Cornell University. Student assistant during Senior year at the University of Pittsburgh and tied for honors for science prize.
Chemist, Macbeth-Evans Glass Company, Pittsburgh, 1902 to 1904.
On Chemistry faculty of the University of Pittsburgh since 1905.
Married, Dec. 16, 1908, to Elrose Reizenstein of Pittsburgh.

Societies, Clubs, and Fraternities

American Chemical Society (Councillor from Pittsburgh Section).
American Ceramic Society (Member of Committee on Publications and Committee on Awards).
American Electrochemical Society.
American Association for the Advancement of Science.
American Association of University Professors.
Pennsylvania Academy of Science.
Chemists' Club of New York City.
Society of Glass Technology of England.
Society of Glass Technology of Germany.
Phi Lambda Upsilon.
Omicron Delta Kappa.
Honorary member Pi Lambda Phi.

Publications

"Carbon Dioxide in the Air of Allegheny Schools," *Proc. Eng. Soc. of W. Pa.*, **19** (1903).
"The Chemist and the Glass Manufacturer," *Trans. Amer. Ceram. Soc.*, **12** (1910); *Chem. Eng.*, 1911.
"Depression of the Freezing Point by Vinegars as a Check on Their Chemical Composition," *Ind. Eng. Chem.*, **3** (1911). Translated and reprinted in *Chem. Ztg.*, Jan. 12, 1911.
"Glass Formulas: A Criticism," *Ind. Eng. Chem.*, **4** (1912). Abstracted in "Eighth International Congress of Applied Chem." reports. Translated and reprinted in *Chem. Ztg.*, Sept. 19, 1912 and *Sprechsaal*, Nov. 7, 1912.
"Glass Miscellanies: Notes," *Trans. Amer. Ceram. Soc.*, **16** (1914).
"Protein Charts," *Ind. Eng. Chem.*, **7** (1915).
"Use of Barium Compounds in Glass," *Jour. Soc. Chem. Ind.*, **34** (1915).
"The Silvering of Glass," *Trans. Amer. Ceram. Soc.*, **17** (1915). (Co-author, P. E. Neckerman).
"Stony Glass; Another Possible Cause," *Trans. Amer. Ceram. Soc.*, **18** (1916).
"Similarity between Aqueous and Vitreous Solutions," *Ind. Eng. Chem.*, **9** (1917).
"A New Illuminator for Microscopes," (first paper), *Ind. Eng. Chem.*, **9** (1917).
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"Fifty Years of Glass Making," *Ind. Eng. Chem.*, **18** (1925); reprinted in *Amer. Glass Rev.*, *Nat. Glass Budget*, and *Glass Ind.*
"Research," chapter in volume entitled Discussion by Leading Authorities, and published by Congress of American Industry, Chamber of Commerce Bldg., Philadelphia (1926).
"The Chemistry Profession: Preparation, Opportunities," *Jour. Chem. Ed.*, IV (1927).
"The Future in Chemical Education," Theta Chi Delta Lecture, Wittenberg College, Oct. 21, 1927.
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U. S. 1,444,400, " " Optical Instruments, Feb. 6, 1923.
Can. 185,283, " " Microscopes, July 2, 1918.
Ger. 381,073, Class 42H, Group 14, Illuminator for Microscopes, Sept. 15, 1923.

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Fr. 489,304, " " " Sept. 13, 1918.
Brit. 125,187, Illuminator for Microscopes, April 9, 1919.
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Lectures and Addresses

GLASS

April 17, 1913, Pittsburgh Section, American Chemical Society.
Feb. 18, 1915, Detroit Section, American Chemical Society.
" 19, " Chemical Engineering Society, University of Michigan.
March 19, " Society of Chemical Industry, New York.
" 22, " Columbia University, New York.
" 24, " New Haven Section, American Chemical Society, Yale.
" 25, " College of the City of New York.
" 26, " Cornell University, Ithaca, N. Y.
May 20, 1915, Pittsburgh Section, American Chemical Society.
Jan. 21, 1916, Chicago Section, American Chemical Society.
Feb. 17, " Cleveland " " " "
March 16, " Philadelphia Section, Amer. Chemical Society.
April 18, " American Chemical Society Convention, University of Illinois.
March 30, 1917, Bucknell University, Lewiston, Pa.
April 6, " Brooklyn Institute of Arts & Sciences.
Nov. 15, " Delaware Section, Amer. Chem. Soc., Wilmington, Del.
Dec. 7, " Youngstown (Ohio) Chemists' Club.
Feb. 26, 1920, Academy of Science and Art, Pittsburgh.
Jan. 13, 1922, Columbia Institute of Arts & Sciences, New York.
" 13, " Brooklyn Institute of Arts and Sciences.
" 16, 1924, Assn. Glass & Pottery Manufacturers, Pittsburgh.
Dec. 30, 1925, Maine Charitable Mechanic Assn., Portland, Me.
Feb. 8, 1926, AMERICAN CERAMIC SOCIETY Annual Meeting, Atlanta, Ga.
Feb. 9, " Rotary Club, Atlanta, Ga.
March 1, " Rochester, N. Y. Section, Amer. Chemical Society.
April 2, " Pa. Academy of Science, Harrisburg, Pa.
Sept. 9, " American Chemical Society Convention, Philadelphia, Pa. (Industrial Division).
Sept. 29, 1927, Akron (Ohio) Section, American Chemical Society.
Jan. 12, 1928, Bryn Mawr College.
March 12, " Erie Section, American Chemical Society.
April 27, " Glass Container Assn. of America, Atlantic City.
May 29, " French Ceramic Society, Paris, France.
June 13, " German Ceramic Society, Meissen, Germany.
Oct. 9, " Pittsburgh Section, AMERICAN CERAMIC SOCIETY.
Oct. 18, " Northern West Virginia Section, Amer. Chemical Society.
Dec. 7, " Toledo Section, American Chemical Society.
Jan. 17, 1929, Detroit " " " "
Jan. 18, " University of Michigan Section, Amer. Chem. Society.
May 2, " Sigma Xi Assn., Columbia University.
Oct. 7, " St. Louis Section, American Chemical Society.
Nov. 22, " Chicago Section, American Chemical Society.
Dec. 12, " Cleveland Section, Amer. Chemical Society.
March 13, 1930, New York Section, American Society of Illuminating Engineers.
" 19, " University of Wisconsin.
" 21, " Milwaukee Section, American Chemical Society.

MICROSCOPE ILLUMINATION

Nov. 15, 1917, Wilmington, Delaware, Chemists.
Dec. 7, 1917, Youngstown, Ohio, Chemists.
Feb. 21, 1918, Pittsburgh Section, American Chemical Society.
Feb. 7, 1919, N. Y. Microscopical Society, and N. Y. Mineralogical Soc., New York City.
March 21, 1919, Society of Chemical Industry, New York.
Jan. 11, 1920, New York Section, American Chemical Society.

Jan. 14, 1920, The Faraday Society and Royal Microscopical Soc., London, England. (Represented by S. C. Akehurst),
Feb. 11, 1921, Royal Institution, London, England (Represented by S. C. Akehurst).

DEGREE OF CERAMIC ENGINEER TO HILTON LOWRY LONGENECKER

Mr. Longenecker fulfilled all the requirements of rules at Ohio State University pertaining to granting of an engineering degree to those graduates of five years standing. His thesis was accepted and his degree was granted June 10, 1930.

W. G. WORCESTER AND H. C. LONGENECKER

Mr. Longenecker's record is as follows:

1911 Graduated Ohio State University.
1911–1912 Southern Clay Mfg. Co., Robbins, Tenn., and Coaldale, Ala.
1912–1913–1914 Manager, Fire Brick Dept., Green Engineering Co., Chicago, Ill.
1914–1915 Supt., A. P. Green Fire Brick Co., Mexico, Mo.
1916–1917 Engineer with Hook Kiln Co., Columbus, Ohio.
1917–1925 Owner and Manager, Cambridge Brick Co., Cambridge, Md.
1925–1930 Gen. Supt. and Sales Manager, Hood Brick Co. of North Carolina, Charlotte, N. C.

PROFESSOR WOLSEY GARNET WORCESTER RECEIVES CERAMIC ENGINEER DEGREE AT OHIO STATE UNIVERSITY

On June 10 Ohio State University honored itself by giving a degree of Ceramic Engineer to W. G. Worcester, Director of the Department of Ceramic Engineering, University of Saskatchewan, Saskatoon, Canada. Professor Worcester has long been favorably known for thorough work and clear reports of researches. He began his university studies in architecture and then changed to ceramics before Ohio State University granted degrees in ceramics. He has always done the grade of work expected of a graduate in ceramics. His friends were proud to present him as a fitting candidate for an honorary degree.

Prof. Worcester's record in part is as follows:

1899 Graduated from Ohio State University; Served in Spanish-American War.
1899–1900 Celadon Roofing Tile and Terra Cotta Co., Ottawa, Ill.
1900–1902 Asst. Supt., Cincinnati Roofing Tile & Terra Cotta Co.
1902–1903 Designed and built the New Lexington plant of the Ludowici-Celadon Co. (Roofing tile).
1903–1904 Designed and built U. S. Roofing Tile plant at Parkersburg, W. Va.
1904–1906 Rebuilt plant at Groveport, Ohio, for The Central Ohio Roofing Tile & Brick Co.
1908–1910 Instructor in Ceramic Department, Ohio State University, with E. Orton, Jr., and Ross C. Purdy. Prepared *Bull.*, No. 11, Ohio Geological Survey, "The Manufacture of Roofing Tile."

1910–1912 General Supt. for The Detroit Roofing Tile Co.
1912–1914 Designed and built Rough-tex face brick plant for The Tregillus Clay Products Co., Calgary, Alta.
1915–1918 On special ceramic work at Hankinson-Hagler Paving Brick Co., Augusta, Ga., and Standard Brick Co., at Crawfordsville, Ind.
1919–1921 On geological survey and ceramic work in Alberta, Canada.
1921 Opened and in charge of the Ceramic Department of Saskatchewan University.
Summers 1921–1922 Natural resource studies in Northern Saskatchewan for the Sask. government.
Summers 1924–1925–1927–1928 Ceramic and natural resource surveys in southern Sask. for the Sask. government.
Summer 1926 To England, Germany, and Czechoslovakia by the Sask. government and Lignite Board in connection with the carbonization and briquetting of Sask. lignite.
Summer 1929 Made a survey and report on the clays and shales of Turner Valley, Alta., for the Department of Mines of Ottawa.

Papers

"The Manufacture of Bedford Shale by the Wet and Dry Processes," *Trans. Amer. Ceram. Soc.*, **5**, 295 (1903).
"The Function of Alumina in Crystalline Glazes," *Trans. Amer. Ceram. Soc.*, **10**, 450 (1908).
"The Manufacture of Roofing Tile," Ohio Geological Survey, *Bull.*, No. 11 (1910); *Clay-Worker* (1911–1912).
"An Investigation of Twenty-One Saskatchewan Ball Clays," *Jour. Amer. Ceram. Soc.*, **12** [5], 360–76 (1929).
"Saskatchewan Clays of Dominion Importance," *Jour. Can. Inst. Mining and Met.*, 1929.

Professor Worcester's most outstanding and important work for the Province of Saskatchewan has been in connection with the development of the refractory clays of the province. Today practically all of western Canada's refractory needs are being supplied by Saskatchewan made ware; formerly there was a 90% importation.

NOTES AND NEWS

AMERICAN REFRACTORIES INSTITUTE

Officers and Directors Elected at the Annual Meeting, May 19, 1930, White Sulphur Springs, W. Va.

President: W. J. Westphalen, Vice-President, Laclede-Christy Clay Products Co., St. Louis.
1st Vice-President: W. B. Coullie, General Sales Manager, Harbison-Walker Refractories Co., Pittsburgh.
2nd Vice-President: P. S. Kier, Vice-President, Kier Fire Brick Co., Pittsburgh.
Treasurer: C. C. Edmunds, Vice-President, McLain Fire Brick Co., Pittsburgh.
Secretary: Dorothy Texter, 2218 Oliver Building, Pittsburgh.
Directors 1930–33 term:
J. M. McKinley, Vice-President, North American Refractories Co., Cleveland.
W. B. Coullie, General Sales Manager, Harbison-Walker Refractories Co., Pittsburgh.
C. C. Edmunds, Vice-President, McLain Fire Brick Co., Pittsburgh.
Roger A. Hitchins, Secretary, General Refractories Co., Philadelphia.
W. H. Peterson, Vice-President, M. D. Valentine & Bro. Co., Woodbridge, N. J.
Chas. S. Reed, President, Chicago Retort & Fire Brick Co., Chicago.
R. M. Sievers, District Sales Manager, Harbison-Walker Refractories Co., St. Louis.
W. J. Westphalen, Vice-President, Laclede-Christy Clay Products Co., St. Louis.

NOTES FROM MELLON INSTITUTE

Director Announces Plans for New Building

Dr. Edward R. Weidlein, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced, speaking for the Board of Trustees, that the institution is to increase its facilities for serving American industries by a building project that will enable the material expansion of all its research activities. Detailed plans are now being prepared by the architects, Janssen and Cocken, of Pittsburgh, and construction will begin as soon as the drawings are completed, early this fall. The Mellon-Stuart Company, also of Pittsburgh, is the general contractor.

The building, which is to occupy the site of the Institute's Building No. 2, is designed on classical lines, a plain, simple, but massive structure, surrounded by columns. It will provide ample space for housing many more Industrial Fellowships than the 63 that now tax the Institute's facilities to the utmost. The other departments of the institution will be increased in proportion.

When the present home of the Institute was completed, in 1915, it was felt that the Industrial Fellowship procedure created by Robert Kennedy Duncan had passed from the experimental to the practical stage. The building, which was given to the institution by Andrew W. and Richard B. Mellon, incorporated the best laboratory constructional features of that period. It was thought then that it would provide adequate space for growth for many years; but for practically 10 years the Institute has had a waiting list of companies, often almost as long as the roster of companies whose problems were being investigated. Even the additional space afforded by Building No. 2, acquired in 1927, gave but temporary relief from the need for more laboratories arising from proposed new investigations and from the necessity of increasing the personnel of fellowships already in operation.

In addition to providing a greatly increased number of laboratories, the new building will give more commodious quarters for the general departments. The present library contains 11,000 volumes; the new library is planned to accommodate 250,000 volumes. The present Department of Research in Pure Chemistry will be expanded and facilities for pure research in other branches of science will be provided. Much more elaborate chemical engineering laboratories are to be available in the new building, and also the fellowships in each specific field of industrial research are to be grouped in suites of rooms so that they can best make use of general apparatus adapted to their needs. Certain rooms will be equipped for specialized phases of experimental technique, such as electrochemistry, spectroscopy, low-temperature studies, radiations, high-pressure experimentation, etc. Other special features to be included are a large lecture hall, a dining hall, an industrial fellowship museum, and an underground garage. For the past five years members of the Institute's Executive Staff have been visiting important laboratories in America and Europe to obtain information on new features in design and equipment.

The new laboratory structure will be of that type of classical Greek architecture known as Ionic. It is to be seven stories high, with monolithic columns along all four sides. The proportions will be approximately 300 by 400 feet. The main entrance, which is located on the third floor, is reached by steps extending along the entire front of the building. The laboratories are to face on interior courts. The design of the new building is to be such that additional laboratory suites can be constructed in the interior courts without marring the beauty of the general appearance and without interfering in any way with the original laboratory units.

Bibliographic List

The third annual supplement to Bibliographic Bulletin No. 2 of Mellon Institute of Industrial Research, Pittsburgh, Pa., has just been issued. This publication lists 7

bulletins, 50 research reports, 59 other papers, and 16 domestic and 15 foreign patents by members of the Institute during the calendar year 1929. The total contributions to the literature for the 18 years ended January 1, 1930, have been as follows: 15 books, 96 bulletins, 528 research reports, 849 other articles, 407 U. S. patents, and 295 foreign patents.

Complimentary copies of the third supplement, as well as of the preceding numbers of the series, will be sent to laboratory directors, librarians, science teachers, and institutional heads who request them.

MEETING OF OHIO CERAMIC INDUSTRIES ASSOCIATION

The Ohio Ceramic Industries Association (all sections except Whiteware) met for its annual spring meeting at Lord Hall, Ohio State University, May 16 and 17. The registration of 45 included an attendance from practically all parts of the state and from all branches of heavy clay products and refractories.

The program on May 16 was devoted to the general subject of "Public Relations."

The first speaker was D. C. Rybolt, State Purchasing Agent, who spoke on "The Use and Purchase of Ohio Manufactured Products by the State Departments and Institutions."

If an individual or corporation desires to be put on the mailing list to receive invitations to bid on state business handled by the State Purchasing Department, he should send a letter to the State Purchasing Agent, D. C. Rybolt, State House, Columbus, Ohio expressing his desire and listing the kind of materials he is prepared to furnish.

The second speaker was Robert N. Waid, State Director of Highways who spoke on "Highway Development in Ohio." Mr. Waid called attention to the fact that Ohio has been developing a state highway system for twenty years and is now one of the leading states in the Union in the number of miles of improved highway which are open for public travel. Forty-three thousand miles of highway are surfaced with materials so that they can be used the year round.

Ohio has never had a bond issue for state road construction. In this it differs from a large number of other states. At the present time, Ohio's road construction and maintenance program is financed mainly from the income of the gasoline tax and auto license money. In addition to state money used for highway construction part of the money is furnished by the county in which the road is being built. Some of these counties have issued short time bonds. These bonds have been pretty largely retired.

The State, at present, is attempting to do two things:

(1) Complete the gaps on present traveled roads where improvements have not been completed.
(2) Widen and rebuild the highways particularly near the larger centers of population.

Statistics show us that 70% of the traveling public using state highways never travel over 30 miles from the origin. This explains the necessity for wide roads near large centers of population.

Interest in brick pavements is greatest in those districts of the state where paving brick are made and less in those districts remote from brick manufacturing plants. Drain tile and vitrified pipe are used for a large part of the highway drainage system. It is the policy of the department to give ceramic producers a fair chance in highway construction when possible.

The third speaker was F. P. Kearns, Supt. of the Division of Safety and Hygiene, Industrial Commission of Ohio. His subject was "State Activities in Accident Prevention in the Ceramic Industries."

The ceramic industry in Ohio contributed to this record including potteries and heavy clay products as follows:

Deaths, 17; total lost time, accidents 3885. These caused a loss in this industry alone of 161,079 days time. Five causes were responsible for 2377 or about 61% of these accidents.

(1)	Handling objects	810
(2)	Falls	416
(3)	Stepping or striking objects	408
(4)	Machinery	378
(5)	Falling objects	365
	Total	2377

The Division of Safety and Hygiene has a staff of expert safety engineers, each familiar with the industries in which he works, to carry on the field work for the Division.

The safety engineer in the ceramic industry is H. C. Goodwin who devotes his full time to the work. Mr. Goodwin is available to assist this industry.

The program of May 17 was devoted to ceramic research. George A. Bole, Chairman of the General Research Committee and Research Professor of Ceramics at Ohio State University, called attention to the fact that the rather rapid development of ceramic research work in the Engineering Experiment Station is due almost entirely to the influence and activities of the O. C. I. A. This work now occupies 7 full-time research men located at Roseville and 2 at the Engineering Experiment Station on the campus. The following twelve researches are now under way.

(1) Engineering data on structural clay tile design.
(2) Pier tests on tile, brick, and concrete.
(3) Engineering data on flat-arch construction.
(4) Fire tests on tile walls.
(5) Mortar investigations.
(6) Light-weight clay products.
(7) Dry-press fire brick.
(8) Clay survey of Ohio.
(9) Power consumption and operation factors.
(10) Dry-press paving brick.
(11) Stoker firing.
(12) Burning characteristics of fuels and furnace design.

The magnitude of the research work is reflected by the following account of the moneys spent for Heavy Clay Products Research in the Engineering Experiment Station at Ohio State University during 1929.

Coöperative funds:		University expenditures:		
Trade Associations	$18,500	Salaries (full time)	17,000	
Harrington Stoker Corp.	6,000	Salaries (part time)	6,000	
Bureau of Mines	8,000	Operating expenses (Roseville)	3,600	
Welfare Department	5,000	Travel	1,000	
		Total	$27,600	
Total	$37,500	Grand Total		$65,100

The following associations are contributing to research:

Structural Clay Tile Assn.
Common Brick Manufacturers Assn.
Eastern Clay Products Assn.
American Face Brick Assn.
National Paving Brick Manufacturers Assn.

H. C. Harrison, Research Engineer located at Roseville, gave a short account of the work now being done on the stoker firing of periodic kilns. He emphasized the idea that a number of difficulties had been encountered in the operation of the stoker but that these difficulties did not indicate that stoker firing could not be successfully done. These difficulties were of the type usually met with in developing something new. They included expansion, cracks in flues with attendant pressure losses, refractory troubles in the stoker, and other various difficulties due largely to improper building in the design of the stoker setting and attachment to the kiln. The stoker is now being reset on a lower level and he anticipates that their troubles will be greatly reduced on the next firing. To date, no figures as to possible economies are available.

Raymond E. Birch of the research staff at Roseville gave a brief summary of his findings on dry pressing of refractories. This work has proved the desirability of forming certain refractory batches under higher pressures than those now commonly used. Some of the advantages to be gained through the use of higher pressures are greater uniformity of finished product, lower firing temperature to attain the same maturity, less slag erosion, less subsidence under load and greater resistance to abrasion. Due to greater density of the green ware, kiln marking is decreased and the added strength should materially decrease other kiln losses.

In its effect on the service behavior of refractories, the principal disadvantage of higher forming pressures appears to be an increase in thermal spalling.

Most plastic clays crack at forming pressures below 1500 pounds per square inch. Pressure cracks appear commercially whenever an attempt is made to utilize the maximum pressure developed by the press. Cracking can be partially forestalled by reduction in moisture content, coarser grinding, and the use of more grog or flint fire clay. The recent experiments at Roseville have indicated the possibility of reducing the cracks and lamination by pressing the brick under a partial vacuum. For example, by evacuating the mold under about one-half atmosphere, it has been found possible to secure faultless brick at 6000 pounds per square inch from mixes which otherwise crack at all pressures above 1500 pounds per square inch.

The adaption of air evacuation to commercial pressing appears to be the only satisfactory method of eliminating cracking so that high forming pressures may be utilized.

It seems to be up to the manufacturers of presses to produce a press which will work with the partial vacuum and develop high pressures, together with the commercial speed necessary.

C. T. Morris discussed the work now being done in the testing of hollow tile flat arch floors. He stated that their work, to date, had been largely concerned with the proper placing and designing of the steel tie rods used in these floors. About two more years of work are necessary to complete the program outlined by the Engineering Experiment Station. It is hoped that this work when completed will furnish sufficiently consistent and accurate data so that a safety factor of 3, such as is now used in concrete design, can be used in floor designing rather than the factor of 7 now commercially used. This would enable the use of lighter floors and allow keener competition with concrete.

H. D. Foster discussed the recent work in the testing of masonry piers. These piers have been built of various sizes and types of units with a combination of hollow tile and brick in accordance with Detroit city building code regulations. Of particular interest in this work, is the fact that the load has been applied in a manner similar to the load usually placed on a pilaster by the deflection of the lower member of the roof truss, thus causing the heavier part of the load to come on the inside of the pilaster. The pilasters tested showed strengths of 489 to 929 pounds per square inch for tile and brick-faced tile construction. Based on the 90 pounds per square inch usual allowable load these pilasters gave a strength varying from 5.4 to 10.3 averaging 7.34 times the legal load.

The Detroit common brick pilasters showed strengths of from 802 to 929 pounds per square inch. This is from 5.3 to 6.2 times the legal load limit which for brick is 150 pounds per sq. in.

The results and types of failures obtained in these tests indicate that a higher allowable unit stress might be advisable.

J. O. Everhart, Roseville staff, discussed some of the work he had been doing in power consumption study in heavy clay products manufacture. So far the work has been confined to Roseville although he expects to extend these studies to other plants in the near future and thus gather data which will be of real interest to the industry.

The Roseville plant in April, 1930, produced a total of 740,000 fired brick which consumed, in plant operation, a total of 28,900 kilowatt-hours of power.

This power consumption was distributed as follows:

	(%)		(%)
Crushing	11.5	Forming	40.0
Grinding	17.7	Conveying	5.8
Tempering	22.0	Drying	3.0
		Total	100.0

Mr. Everhart also stated that he was engaged in a research on the dry pressing of paving brick. To a large extent his findings parallel those of Mr. Birch in the dry pressing of refractories although the project has not been developed far enough at the present time to allow the publication of data.

The remainder of the morning session was devoted to a discussion of the desirability of developing new presses to meet the needs of the refractory industry as indicated in Mr. Birch's talk. Representatives of several of the manufacturers of presses were present and indicated their willingness to coöperate with the refractory industry in the development of such equipment.

Whiteware Division Meeting

The Whiteware Division of the Ohio Ceramic Industries Association held its spring meeting at East Liverpool, Ohio, Tuesday, May 27, 1930. About forty were in attendance.

The group met at the U.S. Potters Association offices. T. B. Anderson, Chairman of the Whiteware Division, introduced the speakers. They were as follows: G. A. Bole, Research Professor of the Eng. Expt. Sta., O. S. U.; G. A. Loomis, Senior Research

Engineer, Eng. Expt. Station, O. S. U.; and A. S. Watts, Professor of Ceramic Engineering, O. S. U.

Prof. Bole spoke on "The Recent Development in Ceramic Research." Mr. Loomis told of the work he has been doing on efficiency tests on updraft kilns at the Crooksville China Co. Prof. Watts gave a short talk on the various experiments that they have been carrying on with feldspars.

The meeting adjourned in order that a group picture could be taken before attending the luncheon at 12 o'clock with the Rotary Club at the Travelers Hotel.

At 1 P.M. a visit was made to the Homer Laughlin China Company Plant No. 8 at Newell, W. Va.

At 4 o'clock the members again met for an Open Forum Session at the U. S. Potters Association rooms at which time Mr. Johnson of the Forrester Firing System Co., Paul Collins, a graduate student at O. S. U. University, Mr. Humphreys of the East Liverpool Ceramic School, A. V. Bleininger, and A. E. Baggs gave short talks, followed by discussions.

Mr. Johnson discussed the merits of Forrester Burning Keys. Mr. Collins gave a short talk on the work he had been carrying on with feldspars. Mr. Humphreys spoke upon the East Liverpool Ceramic School. Mr. Baggs described the research just getting under way on ceramic art at the Department of Ceramic Art at Ohio State University.

The meeting adjourned in time for the members to attend a banquet at 6:00 P.M. at the Travelers Hotel. V. V. Kelsey, Sales Manager of the Consolidated Feldspar Corporation, Trenton, N. J., gave a talk on "Uniformity Control of Feldspar."

Respectfully submitted,

H. E. NOLD, *Secretary*

DIRECTOR OF BAVARIAN HAVILAND FACTORY VISITS VITREFRAX CORPORATION

On May 20, a T. A. T. plane landed W. H. Zimmer, Director, Porzellanfabrik-Waldershof, the Johann Haviland Porcelain Works of Bavaria, at Grand Central Airport, Los Angeles, to be the guest of Thomas S. Curtis, Vice-President in charge of Research of Vitrefrax Corporation for a few days.

Left to right: Wm. Jackson, President Empire China Co., B. J. Williams, Vice-President and General Manager Vitrefrax Corporation, W. H. Zimmer, Director Porzellanfabrik-Waldershof, T. S. Curtis, Vice-President, in charge of Research, Vitrefrax Corporation.

Dr. Zimmer, who is recognized as one of the leading authorities on the manufacture of fine porcelain in Europe, is a charter member of the AMERICAN CERAMIC SOCIETY. He produces "Vitrolin," a fireproof porcelain.

At the close of the technical conferences which brought Dr. Zimmer to Los Angeles, a tour of the city was arranged with the assistance of William Jackson, President of the Empire China Company.

Dr. Zimmer expressed himself as amazed at the cultural and industrial development

of the Southwest, and was particularly impressed with the immense resources of the contiguous desert country.

On the morning of May 23, Dr. Zimmer boarded a plane for Tulsa, Oklahoma, and plans to sail for Germany in the middle of June.

SECOND BRITISH GLASS CONVENTION

The experiment made in September, 1928, when the first British Glass Convention was held at Bournemouth, was such a success that it was then recommended that a second Convention be held at Buxton from Sept. 17 to Sept. 20, 1930.

Walter Chance, J.P., will preside over the Convention proceedings. Topics for discussion will be as follows: (1) "Elimination of Waste in the Glass Industry," (2) "Marketing Methods in the Glass Industry," and (3) "Publicity and Propaganda in the Glass Industry."

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for the Advancement of Science	December 29, 1930 to January 3, 1931	Cleveland, Ohio
AMERICAN CERAMIC SOCIETY	February 23–27, 1931	Cleveland, Ohio
American Concrete Institute	February, 1931	Milwaukee, Wis.
American Electrochemical Society	September 25–27	Detroit, Mich.
American Gas Assn.	October 13–17	Atlantic City, N. J.
American Mining Congress		
Western Division Meeting	October 13–18	El Paso, Texas
Annual Convention	December 1–6	Washington, D. C.
American Society for Steel Treating	September 22–27	Chicago, Ill.
Illuminating Engineering Society	October 7–10	Richmond, Va.
National Electrical Exposition	October 6–11	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 1–6	New York, N. Y.
National Glass Distributors Assn.	December 2–4	Pittsburgh, Pa.
National Safety Council	September 29 to October 4	Pittsburgh, Pa.
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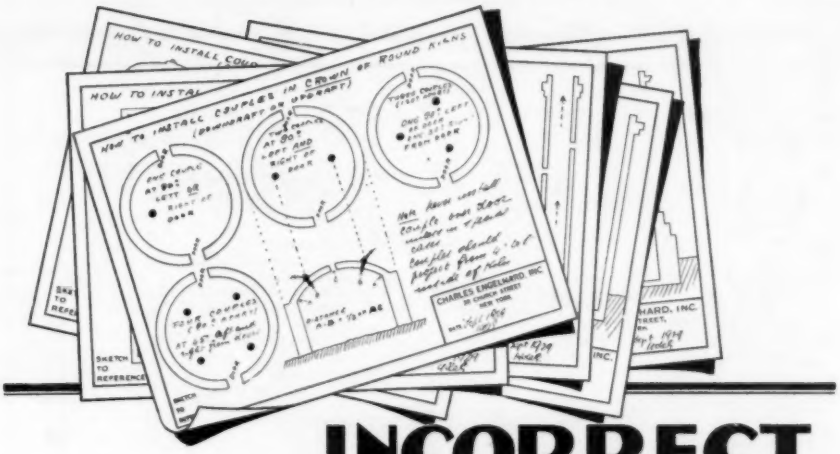

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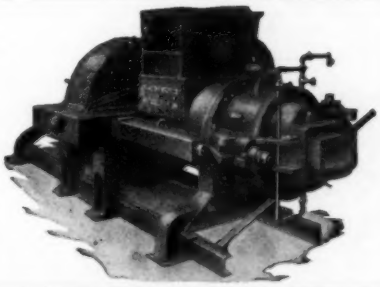

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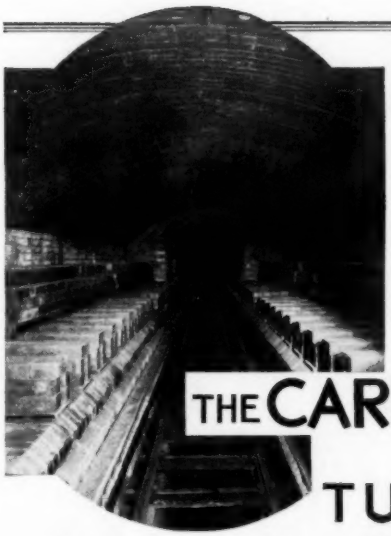

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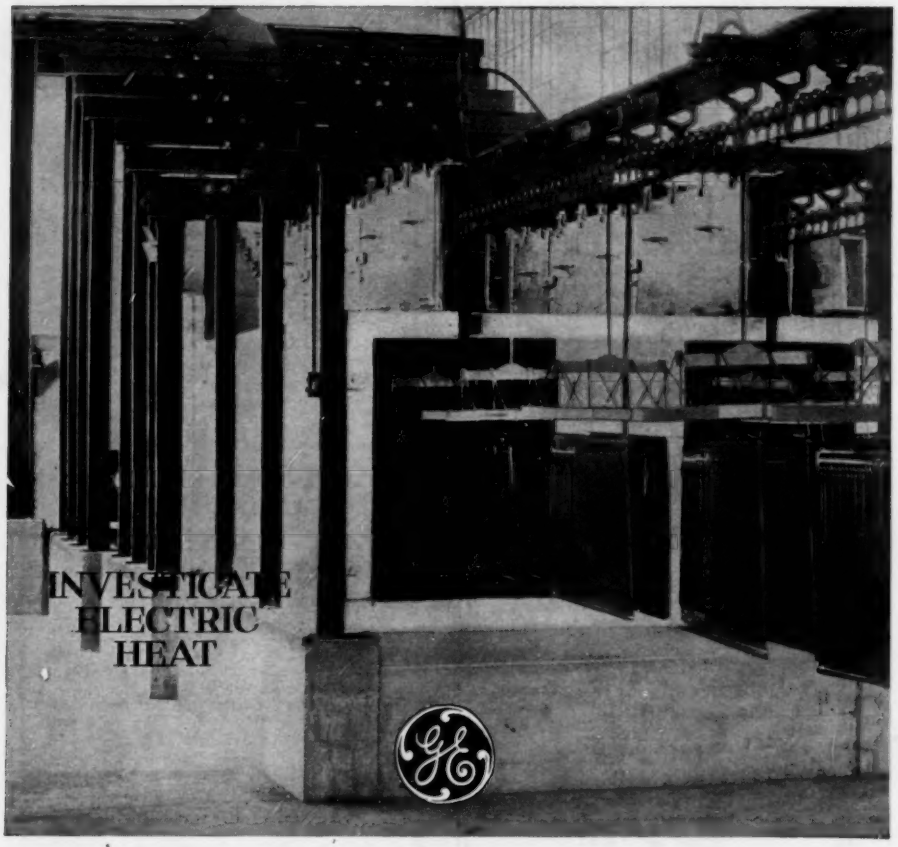

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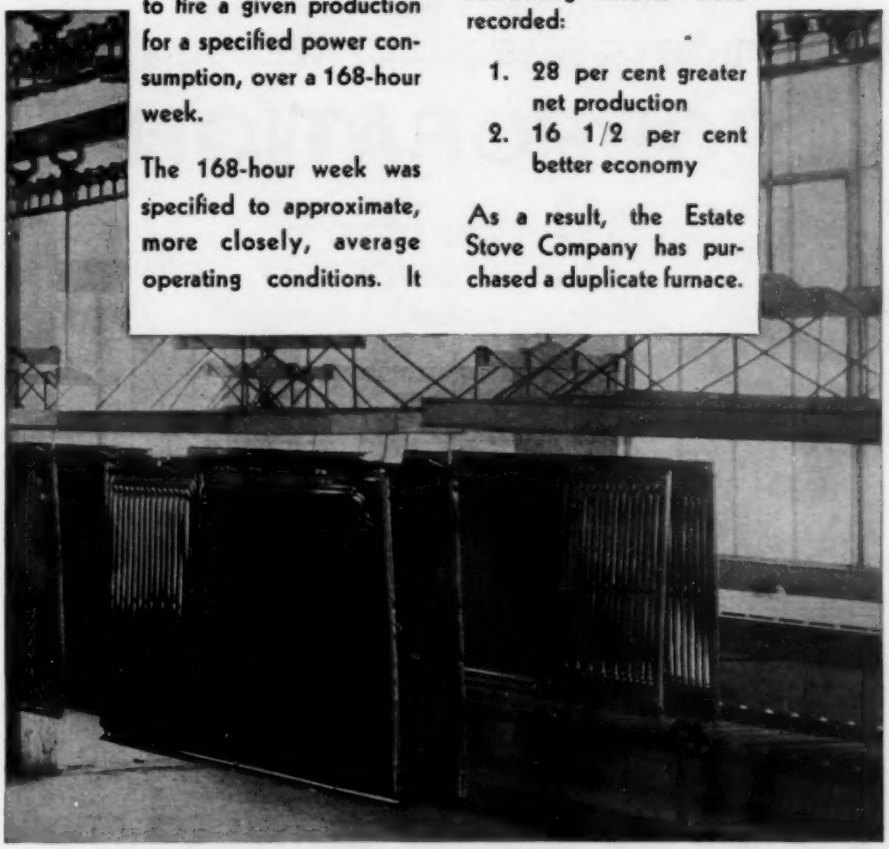

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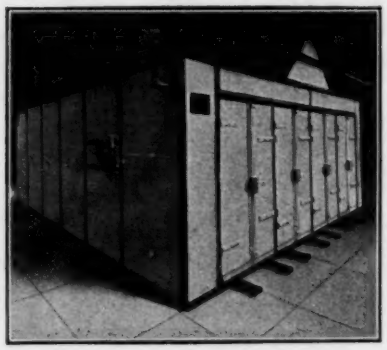

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